# RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

EDITOR

Howard P. Doub, M.D.
Detroit, Michigan

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Vol. 52 JANUARY, 1949 No. 1

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Vol. 52 JANUARY 1949 No. 1

# Immediate and Late Results of Intracavitary Radium Therapy for Malignant Lesions of the Cervix[1]

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SINCE ITS INTRODUCTION, radiosurgery has been an important factor in the treatment of selected early, most borderline, and all late and recurring malignant lesions of the uterine cervix. When this method was first employed, the need was great. As the years passed, it has kept its position, and increase in its use has brought an ever-widening responsibility to the therapeutic radiologist.

Intracavitary radium therapy as an initial method of treatment of malignant disease of the uterine cervix is worthy of sincere consideration by all discerning radiotherapists. Every patient with cancer of the cervix, except for those who are in the terminal phase of the disease, has a chance of cure or of survival for five years or longer at the time she first presents herself for consideration of treatment. The physician selecting and applying the initial therapy has the best opportunity of restoring the patient to health. Naturally, the method selected should be an adequate therapeutic procedure. Today, although the cause of carcinoma is unknown, several methods of treatment are available, from which a selection can be made in order to obtain a good, enduring initial result.

The statistical data to be presented in this paper were prepared by the Division of Biometry and Medical Statistics of the Mayo Clinic. They consist of data on malignant lesions of the uterine cervix treated at the Clinic from 1915, when the use of intracavitary radium therapy was begun, through 1944. During the period studied, 3,798 patients received various types of radium treatment and 2,246 received both radium and roentgen therapy. Generally the information contained in a statistical study can be readily submitted for consideration and the material will furnish some understanding of the topic. Information gained through actual experience and development of methods which will increase skill and judgment cannot be presented so easily or briefly.

## METHODS AND PROCEDURES

Intracavitary radium treatment for carcinoma of the cervix employed in the cases considered here is an intensive, broken-dose procedure, designed for cure or palliation. Treatment is applied in a rather definite period of time by means of an American type of tube container.

*The Intensive Broken Dose:* The dose must be determined by the response or gross change observed in the malignant

[1] Presented at the Thirty-third Annual Meeting of the Radiological Society of North America, Boston, Mass., Nov. 30–Dec. 5, 1947.

lesion and the change observed in normal tissue or structures in and near the field of treatment. The response of the malignant lesion may be apparent in two or three days, while the change in normal tissue, or nearly normal tissue, may occur weeks, months, and years after treatment. The reaction in tissue exposed to ionizing radiation is a complex process. The degree of radiosensitivity exhibited by various body tissues varies greatly. Much study, time, and effort are necessary to establish an effective dosage.

A single application to the cervix employed at present is in the range of fourteen continuous hours or 700 milligram or millicurie hours. This unit dosage is effective in the average case of extensive invasion of the cervix. As a rule, two applications are made to each 2.0 cm. of depth or thickness of involved cervical tissue. For moderately invasive lesions the time factor is reduced to ten hours or a dose of about 500 milligram or millicurie hours. For the lesion confined to the cervix a further reduction in unit dosage is employed.

The dosage applied to the uterine cavity is in the range of twenty to twenty-four continuous hours, or 2,000 to 2,400 milligram or millicurie hours. This dose is applied to each 5 cm. of depth of the uterine cavity (tandem applicator).

The unit dose used for the deep third of the vaginal cavity varies from eight to fourteen continuous hours, or 400 to 700 milligram or millicurie hours. Three applications are used, one to the vaginal face of the cervix and one each to the right and left vaginal fornix.

The dose for lesions of the vaginal wall is determined by the area covered by the flat applicator, which may contain two, three, or four American type tubes. The area covered is measured in square centimeters, and the dose to each area may vary from 80 to 100 milligram or millicurie hours per square centimeter. Several applications may be required to treat the entire vaginal surface of the lesion.

The dosages discussed are relative and are well tolerated by the adjacent normal tissues and structures. Dividing the dose furnishes a recovery period for the normal tissues. This is an important feature of the method. The systemic effects are usually mild.

*Treatment for Cure or Palliation:* The treatment plan for most patients is designed for cure, in that the radium is directed toward the site of greatest infiltration and is well distributed throughout the treatment field. In a small number of cases, however, such distribution is impossible. In this event, treatment is palliative or limited. The chance of cure from such treatment is much less than from other types. Patients with massive lesions receive palliative radium therapy.

*Definite Treatment Period:* The period during which treatment should be applied is rather definite. The patient who has an extensive cervical invasion will tolerate two applications a week for the first half of the course. In many cases, this rate cannot be exceeded because the interval between applications is necessary for the malignant lesion to respond to the treatment. As the response approaches completeness, the anatomic landmarks can be identified and better distribution of the dosage thus becomes possible. The interval between applications is also essential in order that the physician may evaluate the rate of response. Some lesions respond promptly, while others react slowly. For the slowly responding lesions, the interval between applications is increased or more applications are employed. In the average case of lesions confined to the cervix and only moderate invasion there are no technical difficulties, and applications can be given readily. In such cases as many as four applications a week may be employed. Some mild systemic reaction may occur, especially following the intra-uterine tandem application. In cases with extensive invasion the total treatment time may vary from three to four weeks. An interval of three to four months is allowed after the first course of treatment designed for cure. If the response to the initial treatment is satisfactory, a second interval of six

months is allowed, at the end of which time the patient is re-examined. The third interval is nine to twelve months. Annual examinations are recommended thereafter.

*American Type of Radium Tube Container:* The applicator employed is the American type of platinum-iridium tube. The radium sulfate is sealed directly into the tube, and the filtration is 1.0 mm. The radon tube is similar in type, with 0.5 mm. silver and 1.0 mm. brass filtration. The tandem applicator contains two radon tubes, with the filtration mentioned. The colpostat contains one American type tube. The wall of the applicator is 1.0 cm. thick and is made of rubber. The length is about 5 cm., and the diameter 3 cm. The colpostats vary in size on account of the different capacities of the vagina. The flat applicator contains two to four American type tubes, each covered with a rubber tubing wall 2 mm. thick, and all held together with adhesive plaster.

## CHARACTERISTICS OF MALIGNANT LESIONS OF THE CERVIX WITH COMMENTS ON DIAGNOSIS AND PRE-TREATMENT CLASSIFICATION

The diagnosis of carcinoma of the uterine cervix as seen in the average patient who is examined by members of the Section on Radium Therapy of the Mayo Clinic is not a difficult clinical problem. The classical history is one of free irregular vaginal bleeding (spotting) or hemorrhage, with or without serous or mucous discharge. Hemorrhage, odor, and pain are signs of advanced lesions.

Bimanual pelvio-abdominal examination, with vaginal and rectal palpation, usually reveals a solid, hard lesion of the cervix. A few patients, especially the older ones, may have a soft yielding type of cervical lesion. The growth may begin on the surface of the portio vaginalis and be readily seen or it may arise in the portio supravaginalis and be hidden from view.

There are two gross types of lesion, the *protruding* and the *receding* types. The former projects into the vaginal cavity and infiltrates the cervix, while the latter, in the early phase of the disease, invades the cervix and is usually characterized by invasion or infiltration of the body of the uterus, the parametrium, the vaginal walls, and later the neighboring tissues and structures. Both extend or metastasize to the local and peripheral lymph nodes, but the receding type tends to do this more frequently and more quickly.

Palpation alone does not yield sufficient information, and adequate inspection of the vagina is therefore an essential part of the examination. The patient is placed in the knee-chest position and suitably draped. A Sims speculum and a direct source of light are essential for complete vaginal endoscopy. The gross type, location, and probable extent of malignant involvement of the portio vaginalis and of the vaginal wall can be determined. By inspection and palpation of the lesion around the canal with the olive tip of a uterine sound, one can also determine, at least partially, the gross type, location, and extent of involvement of the portio supravaginalis. The location and direction of the uterine canal and the character and source of discharge and bleeding can usually be ascertained, as can the presence of pyometritis or pyometra.

As elsewhere in the body, the microscopic examination of tissue establishes the diagnosis. In our cases, material is now removed routinely for microscopic confirmation of the clinical diagnosis and determination of the grade of malignancy. With judgment and care, it is possible to remove bits of tissue that will indicate the true nature of the lesion in a high percentage of cases. It is seldom necessary to remove tissue a second time on account of a negative report. Over a period of years, in an occasional case negative reports may be obtained from repeated biopsies. My experience with the clinical recognition of small, early primary malignant lesions of the uterine cervix is almost nil. However, my colleagues and I are constantly on the alert to detect small active and metastatic lesions on re-examinations during the immediate post-treatment months or years.

In the event the surface of the cervix or vaginal wall is broken, the everted margin of the lesion, with its red, finely granular surface and characteristic induration, may be accepted as clinical evidence of malignant activity. However, for positive determination of the true status of the small lesion, a representative specimen must be removed for microscopic study.

In the main, the gross differential diagnosis is no real problem, since the majority of patients examined for consideration of treatment have a moderate or advanced stage of the disease. However, we have found in 2 or more cases a degenerating fibroid at the cervical os. The history was not typical of carcinoma, and palpation of the tumor revealed an effaced cervix. On inspection, the tumor surface was rounded, smooth, and without lobulation. The color was uniformly dark red or purple. The texture was tenacious, and the tumor was without a limiting margin. In any event, and especially if the history and physical findings are unusual in any way, surgical consultation should be obtained.

*Grade of Malignancy:* That the higher grades of malignancy are predominant in cancers of the uterine cervix is established by statistical data. In 1,357 cases the grade of malignant change was recorded (Table I). In only 9 cases (0.7 per cent)

TABLE I: MALIGNANT LESIONS OF THE CERVIX, 1915–44: GRADE OF MALIGNANCY (BRODERS)

| Grade of Malignancy | Cases |
|---|---|
| 1 | 9 (0.7%) |
| 2 | 205 (15.1%) |
| 3 | 656 (48.3%) |
| 4 | 487 (35.9%) |
| TOTAL | 1,357 (100%) |

was the lesion of Grade 1 malignancy (Broders). It can be inferred that in this small number of cases the lesions were adenocarcinomas. In possibly 2 or more cases epitheliomas secondary to a leukoplakia of the cervix and vagina were reported. I have never, to my knowledge, treated a primary Grade 1 epithelioma of the uterine cervix. In 1,143 (84.2 per cent) of the 1,357 cases the lesions were of Grades 3 and 4.

TABLE II: MALIGNANT LESIONS OF THE CERVIX, 1915–44: PATHOLOGIC TYPE RECEIVING RADIUM AND ROENTGEN THERAPY

| Type of Lesion | Number |
|---|---|
| Epithelioma | 1,099 (49.0%) |
| Adenocarcinoma | 713 (31.8%) |
| Carcinoma, type not specified | 415 (18.5%) |
| Epithelioma and adenocarcinoma | 16 (0.7%) |
| Endothelioma | 1 |
| TOTAL | 2,244*(100%) |

* In 2 cases the type was not stated.

*Types of Lesion:* The types of lesions receiving radium and supplemental roentgen therapy are listed in Table II. Epitheliomas predominate. The third largest number are recorded as "carcinoma, type not specified." In all likelihood, a great number of these cases should be added to the epithelioma group. In 16 cases a combination of epithelioma and adenocarcinoma was noted on the same microscopic slide.

*Average Age:* The average age of the 2,246 patients receiving both radium and roentgen therapy was 49.1 years. The youngest patient was twenty-one years old; the oldest was eighty-two. Malignant tumor of the uterine cervix is a disease of the menopause, which is one of the most important reasons why it is not recognized in its early stages. It is difficult for the average patient to distinguish the variable menorrhea and menorrhagia of the menopause from the irregular serous or mucous discharge and bleeding from the broken surface of a malignant lesion and its cellular elements. Other features, such as the location and freedom from pain at the onset, are in part responsible for failure to recognize early malignant disease of the cervix.

*Classification of Lesion:* The determination of the extent or stage of the lesion of the cervix is the most important single feature of the pre-treatment examination and consultation. To determine conclusively this individual trait of the primary lesion may be a complicated procedure, since cancer does not advance along a straight line. The selection of the method or methods of management and the prognosis are influenced by the findings. Today the majority of the patients have extensive

lesions when they come for examination. To rule out the possibility of a primary lesion in the body of the uterus, the ovary, vaginal wall, or elsewhere may be a tedious process. Cystoscopic examination may be indicated to exclude involvement of the urinary bladder. Excretory urographic studies may be necessary to determine the presence of an obstruction to the flow of urine. Proctoscopic examination may disclose related rectal lesions. In a small number of cases, dual carcinoma must be ruled out. The stage of the disease should be determined at the time the patient first presents herself for consideration of treatment and should be retained indefinitely as a part of her record.

The two extremes of classification—Stage I and Stage IV—are not too difficult to determine. At least, in comparison there is a marked difference in the findings. They could never be confused.

Lesions confined to the uterine cervix (Stage I) are few in number, and our experience with this stage is meager. In this study there were 2,146 cases in which the stage of the lesion was recorded. Of these, 27 cases (1.3 per cent) are listed as Stage I. The mean age in this small group was 54.5 years.

Lesions which have resulted in massive invasion of the cervix and beyond (Stage IV) are more numerous and may be readily identified. In 394 (18.4 per cent) of the 2,146 cases in which the stage was recorded, the lesions were classified as Stage IV. The mean age of the patients was 50.4 years.

The two middle classifications, Stages II and III, which comprise the majority of the lesions, may be very difficult to determine, at least in comparison with the two extremes. The difference may be very confusing. For example, lesions with moderate invasion of the cervix and beyond (Stage II) may be judged as an advanced Stage I or a beginning Stage III. In 306 (14.3 per cent) of our series Stage II lesions were recorded and the mean age of the patients was 49.9 years. Lesions of Stage III, those with extensive invasion of the cervix and beyond, may be judged as an advanced Stage II or a beginning Stage IV. In 1,419 cases (66.1 per cent) of the present series, lesions of Stage III were present and the mean age of the patients was 49.5 years. Lesions of Stages II and III were thus present in 1,725 cases (80.4 per cent). The problem of proper classification must be met in each case. In some, it is difficult and puzzling, and in a few cases it cannot be definitely determined because of limited procedures and examinations.

Many of the patients who have lesions of Stage I are relatively free of signs and symptoms, the lesions, as a rule, being found at the time of a general physical examination. The signs and symptoms of lesions in Stage II are regarded as somewhat insignificant by the average patient. In these stages there may be relative freedom from anatomic deformation and complications attributable to malignant disease. In such cases, as a rule, there are no technical difficulties in the application of radium. The signs and symptoms of Stage III and IV lesions are in the main typical; only the late phenomena make it urgent for the patient to visit her physician for diagnosis or relief. The chief complaints are excessive bleeding, hemorrhage, pain, and an uncontrolled odor. Excessive anatomic deformation and destruction are brought about through the extensive invasion of tissue, ulceration, and necrosis. These features are responsible for the bleeding, hemorrhage, odor, pain, pyometra, and pelvic cellulitis which are usually considered as complications. The general health may be impaired through loss of blood, toxic absorption, and septicemia, and by the interference in function or destruction of important organs of the body.

*Spread of Lesion:* Primary malignant lesions of the cervix chiefly invade the (1) vaginal walls, (2) body of the uterus, (3) parametrium, (4) peripheral lymph nodes, (5) urinary bladder, with or without fistula, (6) ureters, causing obstruction, and (7) rectum, with or without fistula. Metastasis may occur to distant organs and loca-

tions, as the hymenal region, the skeleton, and lungs.

Direct and isolated involvement of the *hymenal remnants and vaginal walls* at the vaginal inlet can be palpated and inspected, and for confirmation material can be removed for biopsy. As a rule, the primary lesion is larger than the secondary lesions. Infiltration of a large portion of the vaginal wall with definite invasion of part of the cervix may be a true maligant lesion of the cervix, but absolute proof is lacking.

A lesion which has invaded the *body of the uterus* can be partially palpated with the olive tip of a uterine sound. The absence of pain on gentle sounding of the region of the internal os is considered fair evidence of involvement of the uterus at that level and beyond. With the instrument used for endometrial biopsy, tissue can be removed from some of the walls of the uterine cavity. All the walls cannot be reached adequately for removal of a representative specimen. The presence of foul pyometra or intra-uterine hemorrhage is a contra-indication to immediate biopsy.

All infiltrations or thickening in the *parametrium* must be considered as part of the malignant process. The residue of pelvic inflammatory disease, fibroids, and extra-uterine tumors cannot be definitely distinguished.

Some of the *peripheral pelvic lymph nodes*, provided that they are of sufficient size and within reach of the physician's finger, can be palpated. However, their definite status and the extent of their involvement cannot be determined. Enlarged *inguinal lymph nodes* are considered to be involved.

Malignant invasion of the *urinary bladder* is best determined by the urologist. Vesicovaginal fistulas usually can be located and their size determined by vaginal endoscopy with the patient in the knee-chest position. Location and diagnosis of small fistulas may require repeated examinations.

Pelvic *obstruction to the flow of urine* can be determined by excretory urographic methods. Ureterectasis of varying degree, pyelectasis, and non-functioning of the kidney will be recorded roentgenographically. This examination may reveal unrelated pathologic changes in the kidney. All patients who have had previous pelvic operations or irradiation, with clinical or definite evidence of malignant activity present, especially if further irradiation therapy is planned, should undergo excretory urographic study. Excretory urograms also should be obtained in all cases of Stage IV lesions and also in cases in which extensive regional invasion of the anterior vaginal wall has occurred.

Malignant invasion of the *rectum* is best determined by the proctologist. Proctoscopic examination should be done in all cases of rectal complaints in which pelvic irradiation has been carried out elsewhere. It is especially indicated if further treatment is contemplated. Malignant invasion of the posterior vaginal wall with associated ulceration and necrosis may indicate a potential, if not actual, recto-vaginal fistula. If gas escapes through the vagina or if, after a small cotton tampon is placed in the questionable region for a little while, it is soiled with bowel contents, this is good evidence that a small fistula is present.

A routine roentgenogram of the *chest* is definitely indicated in all cases. Pain, such as low backache or unilateral aching of a hip or leg, makes roentgenograms of the *pelvis* essential, though these seldom show positive evidence of metastatic lesions in bone to account for the distress. A routine general examination on admission and the necessary laboratory studies may reveal the presence of malignant involvement in distant structures. It must be kept constantly in mind that the secondary lesions are as insidious in onset as the primary lesion. All complaints and signs, regardless of their kind and location, must be considered as indicating metastasis until proved otherwise.

*Comment:* The problems so far discussed concern the malignant disease, and only a few of its many characteristics have been presented. The proper evaluation of observations concerning the lesion is all-important in the proper classification of the

disease in each patient. These findings should be a part of every treatment record. The patient should be carefully observed throughout the initial course of treatment, since the therapeutic management of the various features of the disease is the first principle of individualized irradiation therapy.

### IMMEDIATE RESULTS OF TREATMENT OF LESIONS OF STAGES I AND II

The ideal immediate result of intracavitary radium therapy of malignant lesions of the cervix occurs in terms of days and is characterized by a rather prompt disappearance of the signs and symptoms and a gradual restoration of the patient to good health. The ideal result on follow-up examination of the pelvic genital organs after an interval of three or four months is absence of malignant activity, with minimal scarring and contractures. If the patient then maintains the gain during twelve to eighteen months, the chances are good for continuation into the three-year-arrest period. It is most encouraging to know that patients who are in the three-year-arrest period, free of malignant disease, are good candidates for a cure of five years or more.

The stage of the lesion influences the immediate result. The immediate result of treatment of lesions of Stages I and II is uniformly good.

### TREATMENT AND IMMEDIATE RESULTS OF LESIONS OF STAGES III AND IV AND THEIR COMPLICATIONS

The therapeutic radiologist has a dual obligation in treatment of lesions of Stage III or IV, in that he must treat the malignant disease effectively and treat or control the complications. The radium tube and radium applicators must be inserted without trauma, or with minimal trauma, and held securely in place. As previously mentioned, two or more days must be allowed between applications in order to determine the tissue response and in order that the normal tissue in the treatment field may recover. At the time of each application of radium, a diligent search is made to locate the cervical canal and uterine cavity. In the average case, as the proximal portion of the cervix is treated, the distal portion is located for subsequent treatment. The plan is to treat at least once the proximal and distal portions of the cervix before a tandem applicator is placed in the uterine cavity. The intrauterine application is intended (1) to expose invading malignant cells in the uterine walls, if present, and (2) to reduce the functional activity of the endometrial tissue and thus minimize the occurrence of post-treatment hematometra or pyometra.

Bleeding as a complication of malignant disease of the cervix may be of (1) the capillary type, (2) the venous type, or (3) the arterial type. Radium therapy and gauze packing are necessary for the control of all types. The capillary and venous types are most common and are rather readily controlled. Gauze bandage 2 inches (5 cm.) wide is used for packing the vagina, to fix the radium applicators in place, and to obtain as much distance as possible between the radium and the normal tissue structures. Patients who have bleeding of the capillary or venous type receive some special attention, in that the gauze packing is divided at the time the radium application is made. Part of the packing is removed with the radium at the end of the treatment and the remainder is removed later, or more packing is subsequently inserted if necessary. After two or three radium treatments, with removal of packing from the vagina as described, bleeding is controlled.

The arterial type of bleeding is more difficult to control and as a rule is an indication for the omission of radium treatment. The method of vaginal packing is the same as for capillary or venous bleeding with the added feature of sustained pressure, which is obtained and maintained by insertion of as much gauze as possible in the vagina, vaginal inlet, and vulva. The labia are separated and a quantity of packing is formed and compressed to fill the area. A small hand towel is folded in the shape of a

commercial vulva pad and used to reinforce the vulval pack. All this is held in place by a strip of adhesive tape, one end of which is fixed to the suprapubic region and the other end to the sacral region. A T-binder is snugly fitted to the patient for added external support of the packing. An ordinary rubber catheter is placed for bladder drainage just before the packing of the vulva is started. If the external packing is free of blood for an interval of twenty-four hours, the T-binder is released. In another twenty-four hours the packing in the vulva is removed together with the catheter. The remainder of the packing is removed in small amounts, preferably with the patient in the knee-chest position for satisfactory vaginal endoscopy. If any evidence of fresh bleeding is found, the remaining packing is reinforced with more gauze. At this time a strip of petrolatum gauze may be incorporated in the packing material. Five to seven days may pass before all of the original packing is removed. In some cases sedatives, including morphine sulfate, are necessary. A very few patients may require surgical intervention. The control of loss of blood reduces the necessity of blood transfusions to a minimum. Blood transfusions are required in less than 1 per cent of the cases in the course of the initial treatment.

The next most frequent complication of malignant lesions of the cervix is ulceration and necrosis of the cervix, with a poorly draining pyometra. This complication is usually encountered at the time of the first course of treatment and will respond to radium treatment and local measures. Patients who have ulcers, necrosis, and craters are treated as follows: The radium tube is rolled in sufficient gauze to make a cylinder of a size to fit the crater. The depth and the width of the crater as well as the response to treatment determine the number of applications of radium. The local measures are cleansing procedures, the removal of necrotic tissue and discharge from the crater, and the placement of iodoform gauze packing sufficient lightly to fill the crater. The average lesion will respond nicely to such treatment in a rather brief period.

Pyometra is controlled by satisfactory drainage before radium is placed in the uterine cavity. To accomplish this, a wick of iodoform gauze is placed in the cervical canal and uterine cavity. In a small number of cases the cervical canal is tortuous and a metal uterine sound cannot be passed into the uterus. In such cases, a small rubber catheter may be gently introduced, the remainder of the catheter being placed in the vagina, held in position with a small amount of gauze packing. The following day the catheter is replaced by a larger catheter. This technic will produce a straight smooth-walled canal through the malignant tissue into the pyogenic cavity. In some cases, the uterine cavity is irrigated with an aqueous bactericidal preparation under hydrostatic pressure. The patient is usually kept ambulatory.

Fever of 102° F. or more with pelvic tenderness, with or without increased pelvic infiltration, is an indication for rest in bed. Medical consultation is obtained and supportive measures are instituted, including the administration of sulfonamide drugs and the new germicidal preparations, as indicated. Treatment with radium is temporarily stopped, to be resumed in a matter of days or weeks, or as soon as the patient is able.

Through the years the number of cases of minor and major inflammatory and hemorrhagic complications is small, probably less than 15 per cent of the total cases in which treatment is given. In only a few cases, probably less than 5 per cent, are hospitalization and temporary abandonment of the radium therapy required. The control of these complications by immediate active measures has definitely influenced our immediate results. So far, we have found no substitute methods of treatment for the control of these potentially serious complications.

Patients who have systemic diseases or conditions unrelated to the malignant disease are seen in consultation with physicians especially interested in the coincident dis-

TABLE III: MALIGNANT LESIONS OF THE CERVIX, 1915–44: FIVE-YEAR SURVIVALS ACCORDING TO TYPE OF TREATMENT*

| Type of Treatment | Total Number of Patients | Number of Patients Traced | Lived Five Years or More After Leaving Hospital | |
|---|---|---|---|---|
| | | | Number | Per cent of Traced Patients |
| Radium therapy alone | 405 | 354 | 50 | 14.1 |
| Radium and roentgen therapy | 1,799 | 1,581 | 519 | 32.8 |
| Roentgen therapy alone | 88 | 71 | 11 | 15.5 |
| Operation alone | 381 | 364 | 106 | 29.1 |
| Operation and radium therapy | 112 | 106 | 45 | 42.5 |
| Operation and roentgen therapy | 57 | 38 | 13 | 34.2 |
| Operation and radium and roentgen therapy | 217 | 188 | 113 | 60.1 |

* Inquiry as of Jan. 1, 1945. Included here are only those patients treated five or more years prior to the time of inquiry, that is, in 1939 or earlier.

ease. Those having diabetes mellitus are well prepared before radium therapy is given. Those with cardiac or renal disease may be given radium treatment and may remain on the appropriate hospital service for the cardiac or renal condition. The best that medical and surgical management can give will improve the results of irradiation therapy.

This discussion is not intended to exhaust the topic of inflammatory and hemorrhagic complications and associated systemic diseases, but rather to call attention to the importance of the immediate effective treatment of the malignant and the systemic disease. With few exceptions, the local complications can be treated and controlled, and consultation concerning the treatment of the systemic complications attributable to, or unrelated to, the malignant condition may be salutary.

## LATE RESULTS

The late results of treatment, or the survival rates for five or more years, will be presented, in part, in a statistical manner. The type of treatment, the period of treatment, and the stage of the lesion affect these results.

Before going on to the statement of results, it may be well to review the progress made in treatment methods in the period 1915 through 1945, which is covered by this study. Early experience with radium therapy has resulted in the selection of a satisfactory metal container for the radium; in the determination of the lethal and sublethal doses for the malignant tissue, of a tissue tolerance dose for the normal structures in the field of treatment, and of a dose that the patient can tolerate; in the determination of a technic for the placement, fixation, and removal of the radium applicator. Management of cases of carcinoma of the uterine cervix has gone through a transitional phase from chiefly surgical to irradiation management. Radium therapy was first used mainly for postoperative recurrences or for very extensive primary lesions. The early practice was to give two or more treatments and to ask the patient to return in six to eight weeks for further consideration. A definite improvement could be noted at that time, and two or more additional treatments were given. Some patients would receive many treatments during one or two years. The earlier technic did not provide for distribution of the irradiation. However, the observations and experiences thus afforded furnished the groundwork for the present-day complete and limited radium treatment designed for cure or palliation.

Roentgen therapy could be discussed in a similar manner. With the development of 135-kv. equipment, the treatment was considered by many thoughtful physicians to be effective. However, with the installation of 200-kv. equipment with effective filtration and large pelvic fields, the treatment was rather generally accepted as a routine procedure.

*Type of Treatment:* During the period of this study, 3,059 patients were grouped according to the type of treatment they received and the five-year survival rates

TABLE IV: MALIGNANT LESIONS OF THE CERVIX TREATED BY RADIUM AND ROENTGEN RAYS, 1915–44: FIVE-YEAR SURVIVALS ACCORDING TO PERIOD OF TREATMENT*

| Period | Total Number of Patients | Number of Patients Traced | Lived Five or More Years After Leaving Hospital | |
|---|---|---|---|---|
| | | | Number | Per cent of Traced Patients |
| 1915–19 | 183 | 179 | 16 | 8.9 |
| 1920–24 | 433 | 423 | 116 | 27.4 |
| 1925–29 | 494 | 482 | 196 | 40.7 |
| 1930–34 | 389 | 365 | 127 | 34.8 |
| 1935–39 | 300 | 132 | 64 | 48.5 |

* Inquiry as of Jan. 1, 1945. Included here are only those patients treated five or more years prior to the time of inquiry, that is, in 1939 or earlier.

were determined (Table III). When multiple methods were employed, the treatment listed was not always carried out in the order mentioned in the table, though all methods listed were employed in each case so classified.

The highest five-year survival rate was obtained in a group of patients treated by operation, radium, and roentgen rays. This group contained 217 patients. Of these, 188 were traced, and of this number 113 (60.1 per cent) lived five or more years after leaving the hospital. Most of these patients had lesions of Stages I and II, with a few probably of Stage III. This group does not exceed 20 per cent of the patients seen today who would be eligible for this type of treatment.

The next highest five-year survival rate was obtained in patients treated by operation and radium. Radium therapy was probably used as a postoperative procedure in most of these cases. Many patients were treated postoperatively with radium before roentgen therapy was accepted as a routine procedure. A limited number of these patients received preoperative treatment with radium and it was encouraging to know that in some cases no malignant activity could be found in the specimen removed at operation. The surgical comment was that operation was not made more difficult by previous radium therapy, the fascial planes separated easily, oozing of blood was much less than usual, and healing was not delayed. The use of radium in the preoperative preparation of selected patients who have malignant lesions of the uterine cervix is as yet undeveloped; however, such preparation would greatly reduce the chance of local recurrence and distant metastasis.

In the group showing the next highest five-year survival rate treatment was by operation and roentgen rays. Postoperative roentgen therapy was employed in selected cases in our early experience and later was accepted as a routine treatment.

It is reasonable to assume that the groups so far discussed are made up of selected patients and that, if these same patients were treated today, all would be included in one group.

The largest group consisted of 1,799 patients who received both radium and roentgen therapy, the treatment being given in the order recorded. The results in this large group are shown in Tables IV and V.

In the group of patients who received roentgen therapy alone, 15.5 per cent of those traced lived five or more years after leaving the hospital. In the main, this group is made up of patients for whom palliation only was expected. It gives satisfactory proof that external roentgen therapy has a definite place in the treatment of malignant lesions of the uterine cervix.

In the final group, radium therapy alone was employed, and 14.1 per cent of the traced patients lived five or more years after leaving the hospital. Most of these patients were treated in the early years. In many instances, only a limited treatment, in the light of our present management of similar cases, was applied. For some patients palliation was all that could be expected. In the main, this courageous

TABLE V: MALIGNANT LESIONS OF THE CERVIX TREATED BY RADIUM AND ROENTGEN RAYS, 1915–44: SURVIVAL RATES ACCORDING TO STAGE OF LESION*

| Stage of Lesion | Lived 3 or More Years After Leaving Hospital | | | | Lived 5 or More Years After Leaving Hospital | | | | Lived 10 or More Years After Leaving Hospital | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total Number of Patients | Number of Patients Traced | Number | Per Cent of Traced Patients | Total Number of Patients | Number of Patients Traced | Total | Per Cent of Traced Patients | Total Number of Patients | Number of Patients Traced | Total | Per Cent of Traced Patients |
| I | 20 | 17 | 13 | 76.5 | 19 | 17 | 10 | 58.8 | 16 | 12 | 4 | 33.3 |
| II | 193 | 124 | 91 | 73.4 | 163 | 118 | 77 | 65.3 | 107 | 94 | 45 | 47.9 |
| III | 1,019 | 887 | 376 | 42.4 | 958 | 869 | 293 | 33.7 | 827 | 766 | 165 | 21.5 |
| IV | 219 | 164 | 32 | 19.5 | 189 | 158 | 26 | 16.5 | 143 | 135 | 12 | 8.9 |
| Modified | 440 | 391 | 114 | 29.2 | 418 | 374 | 94 | 25.1 | 362 | 340 | 57 | 16.8 |
| Not stated | 60 | 48 | 23 | 47.9 | 52 | 45 | 19 | 42.2 | 44 | 35 | 7 | 20.0 |
| TOTAL | 1,951 | 1,631 | 649 | 39.8 | 1,799 | 1,581 | 519 | 32.8 | 1,499 | 1,382 | 290 | 21.0 |

*Inquiry as of Jan. 1, 1945. Included in the three-year group are those patients treated three or more years prior to the time of inquiry, that is, 1941 or earlier; the five-year group includes those patients treated in 1939 or earlier; the ten-year group includes those patients treated in 1934 or earlier.

group of patients led the way for the development of a better and a more effective method of radium therapy.

*Period of Treatment:* It is obvious that the period of treatment should influence the late result. Five-year survival rates arranged according to the period of treatment may be considered a chronological presentation (Table IV). No attempt will be made to list the events, in the order of their occurrence or importance, that advanced the science and art of irradiation therapy.

In the first period, 1915 through 1919, 183 patients were treated; of these 179 were traced and 16 patients, or 8.9 per cent, lived five or more years after leaving the hospital. This percentage of survival proved that radium and roentgen therapy were worthy to be advanced from the field of palliative therapy to the field of curative therapy. It was during this period that radium was commercially extracted in the United States, making larger amounts available for treatment purposes. The supply at the Clinic was increased and a radon plant was installed. A wide variety of treatment applicators were made possible.

By the second period, 1920 through 1924, due to the combined efforts of the therapeutic radiologist and the physicist, the tissue tolerance dose was fairly well established. Radiologic societies were active, and a more rapid exchange of experiences and ideas was possible. The treatment of lesions on the body surface was more successful than the treatment of semihidden or hidden lesions within the body. Exposure of the involved region was an essential feature of good irradiation therapy, as well as the prompt recognition of complications and their management. The knee-chest position was found to be most suitable for the visualization of malignant lesions of the cervix and associated complications and for the placement and maintenance in place of radium applicators. Since that time all patients have been treated in this position with the exception of the crippled who could not assume it. Prior to this period radium therapy was, for the most part, of the limited or palliative type. With proper exposure, the cervical canal and uterine cavity could be located with minimal trauma, and distribution of the radium was added to the technic. The treatment time was condensed into terms of days rather than months and years. Radium therapy for cure is not repeated. Roentgen therapy was accepted as a routine procedure during this second period, the 200-kv. installation, large pelvic fields, greater distance, and more effective filtration being employed.

In the third period, 1925 through 1929

(Table IV), confidence in irradiation therapy was growing. Patients who had lesions more favorable for cure were being treated. The associated local complications were recognized more promptly and managed more effectively. Patients who had systemic complications were receiving the best treatment medical and surgical management could offer.

In the fourth period, 1930 through 1934, the five-year survival rate declined from 40.7 in the third period to 34.8 per cent. This decline could be accounted for, at least in part, if a more detailed study were made of the probable factors. Mention may be made of the depression of 1929 and the probability that consequently more patients with neglected or advanced lesions were treated.

In the fifth period, 1935 through 1939, 48.5 per cent of the traced patients lived five or more years after leaving the hospital, but only 44 per cent were traced.

*Stage of the Lesion:* The classification of the lesion into stages is most important, since the stage influences the method of treatment to be employed and the immediate and ultimate or late result that can be expected. The survival rates recorded in Table V are based on the number of patients treated and the number of patients traced relative to the time of the inquiry (Jan. 1, 1945).

Patients who obtain a good initial result and who maintain this gain through the first twelve to eighteen months, and who are in the favorable classifications, are fine candidates for a three-year arrest of the disease. Patients who have maintained this gain for three years are good candidates for a five-year cure.

There were 1,799 patients in this study who were treated long enough before Jan. 1, 1945, to be candidates for five-year cures. Of these, 1,581 patients were traced, and 519 patients (32.8 per cent) were living five years or more after leaving the hospital. There are 1,499 patients in this study who had undergone treatment ten years or more before the inquiry. Of these, 1,382 patients were traced, and 290 patients (21 per cent) lived ten or more years after leaving the hospital.

The number of patients seen and the number of patients treated has been determined at the time of our annual reports of the work done in the Section on Radium Therapy. There are various reasons why patients do not remain for treatment: (1) recent irradiation therapy elsewhere; (2) recheck examinations after treatment given elsewhere, at which no malignant activity is demonstrated; (3) terminal or hopeless conditions; (4) the decision of the patient or responsible party to have treatment given nearer home. About 2 per cent of the total patients seen do not receive treatment.

## SUMMARY

In this presentation are recorded data prepared by the Division of Biometry and Medical Statistics of the Mayo Clinic, concerning patients with malignant disease of the uterine cervix treated at the Clinic by irradiation from 1915 through 1944.

During the period of inquiry, 3,798 patients received various types of radium treatment. Of these, 2,246 (59.1 per cent) received initial radium therapy and supplemental roentgen therapy, and they are the patients chiefly considered in this discussion.

The stage of the lesion was recorded in 2,146 cases as follows: Stage I (lesions confined to cervix), 1.3 per cent; Stage II (moderate local invasion), 14.3 per cent; Stage III (extensive local invasion), 66.1 per cent; Stage IV (massive local invasion), 18.4 per cent of the classified group.

In the main, the initial radium therapy employed may be defined as an intensive broken-dose procedure, designed for cure or palliation, applied in a rather brief period. To give the radium, the American type of tube containing 50 milligrams of radium sulfate (element) was employed and treatment was supplemented by a course of roentgen therapy from a 200-kv. installation. Total treatment time is about twenty-one days for the average lesion of Stage III.

Five-year survival rates according to the stage of lesion for 1,631 traced cases were as follows: 58.8 per cent for lesions of Stage I; 65.3 per cent for lesions of Stage II; 33.7 per cent for lesions of Stage III; 16.5 per cent for lesions of Stage IV; 25.1 per cent for modified lesions (previous treatment elsewhere), and 42.2 per cent for a small group for whom the stage of the lesion was not recorded. The five-year survival rate for all patients traced was 32.8 per cent.

For various reasons, about 2 per cent of the patients referred to the Section on Radium Therapy were not treated. The hospital mortality was in the range of 1 per cent.

The treatment of choice in the management of the Stage III, Stage IV, selected Stage I, and most Stage II malignant lesions of the uterine cervix is well planned radium and roentgen therapy.

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SUMARIO

**Resultados Inmediatos y Tardíos de la Curieterapia en las Lesiones Malignas del Cuello Uterino**

Desde 1915 hasta y 1944, 2,246 enfermas con lesiones malignas del cuello uterino recibieron tanto curieterapia inicial cuanto roentgenoterapia suplementaria.

El período de la lesión fué anotado en 2,146 casos, siendo éste: Período I (lesiones limitadas al cuello), 1.3 por ciento; Período II (invasión local moderada), 14.3 por ciento; Período III (invasión local extensa), 66.1 por ciento; y Período IV (invasión local masiva), 18.4 por ciento del grupo clasificado.

Toscamente, puede definirse la curieterapia inicial empleada como procedimiento intenso de dosis fraccionadas, destinado a curación o paliación, y aplicado en un período de tiempo algo breve. Para administrar el radio, se utilizó la ampolla de tipo Estadounidense conteniendo 50 miligramos de sulfato de radio (elemento), suplementando el tratamiento con una serie de roentgenoterapia procedente de una instalación de 200 kv. Para la mayoría de las lesiones del Período III, el tiempo total de tratamiento es de unos 21 días.

En 1,631 casos localizados y clasificados conforme al período de la lesión, las sobrevivencias de cinco años representaron: 58.8 por ciento para las lesiones del Período I; 65.3 por ciento para las del Período II; 33.7 por ciento para las del Período III; 16.5 por ciento para las del Período IV; 25.1 por ciento para las lesiones modificadas (tratadas anteriormente en otra parte); y 42.2 por ciento para un grupillo en el que no se anotó el período de la lesión. El coeficiente de sobrevivencias de cinco años para todas las enfermas localizadas ascendió a 32.8 por ciento.

Por varias razones, aproximadamente 2 por ciento de las enfermas enviadas a la Sección de Curieterapia no fueron tratadas. La mortalidad hospitalaria quedó en el renglón de 1 por ciento.

Al parecer del A., el tratamiento de elección en la assistencia de las lesiones malignas del cuello uterino del Período III, Período IV modificado, Período I seleccionado y la mayoría de las del Período II consiste en la curie- y la roentgenoterapia bien orientadas.

# Intravaginal Roentgen Therapy in Cancer of the Cervix Uteri[1]

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CANCER OF THE cervix uteri has been treated at Memorial Hospital (New York) from 1918 to 1945 largely by radium and roentgen rays. From time to time the dosage and technic have been varied and the results of these variations have been reported in several summarizing papers.

In 1931 Healy (6) reviewed the 1,574 cases treated from 1918 up to that time. The treatment during these years had been by local application of radium against the cervix and in the cervical canal and by external irradiation with a radium pack held 4 cm. away from the skin, or, later, with low-voltage roentgen rays (140 kv.p., 2 mm. Al filter, 30 cm. target-skin distance), four doses of 400 r each being administered. Of the patients treated by these methods between 1918 and 1926, 22.5 per cent were free of cancer at five years.

In 1937, Healy and Frazell (7) reported the results of 200-kv. therapy (50 cm. target-skin distance and 0.5 mm. Cu filtration) with a dose of 700–750 r to each of four fields. The radium exposure remained as in the earlier period, 3,000 mc. hr. in a cervical tandem and 1,500 mc. hr. against the cervix in a vaginal applicator, the "bomb." For 551 cases treated from 1928 to 1931 the five-year survival rate was 27.7 per cent.

In 1943 Healy and Twombly (8) compared the effects of the above "massive-dose" type of treatment with the so-called "pyramidal-dose" technic, characterized by treatments increasing from 100 r to 350 r to each port, and with another method called by them "divided-dose" therapy. In the latter roentgen irradiation was given through six 10 × 14-cm. ports around the pelvis, two anterior, two posterior, and one over either hip, the factors being 200 kv.p., 0.5 mm. Cu half-value layer, 0.9 mm. Cu filtration, 30 ma., and 70 cm. target-skin distance. The daily dose was 200 r in air to each of two fields, the total dose 2,000 to 2,400 r per field. Again radium bomb and tandem were used locally.

In this series of cases a 35.4 per cent five-year cure rate was obtained with the "divided-dose" type of therapy, a 28.5 per cent five-year cure with "massive dose." No five-year figures were available for "pyramidal dose" technic, but at three years only 30.2 per cent were free of disease. From these studies, it was concluded that external roentgen therapy added materially to the cure rate in cancer of the cervix and that multiple small doses given at 70 cm. target-skin distance through multiple portals, to the limit of skin tolerance, were to be preferred to single larger doses at shorter distances.

In 1943 it was decided to attempt a comparison of various substitutes for the local application of radium against the cervix in the apparatus known as the "bomb," the form of external irradiation, namely, the "divided-dose" technic described above, being kept constant. It was pointed out by the Physics Department of Memorial Hospital that, since the radium technic was practically contact application, the dose delivered to the depths of the parametria must be exceedingly small as compared with the surface dose, in accordance with the working of the inverse-square law. Nolan and Quimby (13) studied the problem from the physical point of view and recommended the insertion of gold-filtered radon needles through the vaginal vault in a special pattern described by them as constituting the most effective way of delivering a cancericidal dose to the parametria.

Beginning in January 1943, the cases of

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cancer of the cervix seen at Memorial Hospital were first classified according to the League of Nations classification, and the cases of each stage were put alternately into Group A or Group B. By this procedure an attempt was made to get two groups of patients each containing as nearly as possible an equal distribution of early and advanced lesions. External irradiation was given in all cases: 200 r × 10 or 12 to each of six 14 × 11-cm. pelvic ports at 200 to 250 kv., 70 cm. target-skin distance, half-value layer 0.9 mm. Cu or 2.0 mm. Cu. All received 3,000 mc. hr. of radon in a cervical applicator, the lower half of which was loaded with twice the strength of radon present in the upper half (the part which lay in the uterine cavity), the filtration being 0.5 mm. of gold or platinum. Group B patients received in addition approximately 3,000 mc. hr. from parametrial radon needles. Group A, instead of being treated with parametrial needles, received roentgen therapy through special vaginal cones.

After two years of this comparative study, it became apparent that the needle insertion technic, at least as carried out at Memorial Hospital, was a dangerous and ineffective method, conducive to the formation of rectal and bladder fistulae, and to the production of extensive local necrosis, hemorrhage, pain, and troublesome rectal and bladder symptoms. The cure rate in the series treated with needles was low. Consequently, at the end of December 1945, the method was given up and a paper by Taylor and Twombly (16) describing the results was published in 1946.

The object of the present communication is to describe in more detail the exact technic used in the 113 cases (referred to above as Group A) treated with intravaginal cones and to give an account of their present status. For the latter purpose, we have limited ourselves to those patients who were treated three years or more ago, so that we may make some sort of comparison with the three-year end-results described by Healy and Twombly (8) for "massive," "pyramidal," and "divided-dose" therapy plus a vaginal bomb and cervix applicator.

Fig. 1. Master cone with periscope with an intravaginal cone attached and two other cones of different size, with their obturators, one inserted and the other at the side.

## APPARATUS AND TECHNIC

In 1942 some tentative experiments were tried with a special cone developed for the treatment of intraoral carcinoma. After using these cones in a very few patients, it became obvious that the open end of the instrument made the insertion difficult and painful. A rounded obturator to close the open end and push away smoothly and gently the sensitive urethra and anterior vaginal wall was devised. With its use the cones could be inserted easily without hurting the patient. Not only did less trauma result, but larger cones could be used. The cones were fitted into a master cone on a 120-kv. shock-proof machine, and routine treatments were begun in January 1943.

From then until 1945 the procedure consisted of four treatments of 500 r each, total 2,000 r, given directly to the cervix, usually through a cone 4 cm. in diameter. A smaller cone, 3 or 3.5 cm. in diameter, was used to treat the fornices, at a 30° angle. At each treatment 750 r were given, and again each area received four treatments, or 3,000 r. Considerable effort was made to avoid overlapping of vaginal ports, but in many cases this occurred to some extent at the level of the vaginal mucosa, though not

Fig. 2. Insertion of cone in the vagina. Obturator in place.
Fig. 3. Inspection of cervical cancer through the cone to allow proper positioning.

higher up. The factors used in these treatments were 120 kv., filter 3 mm. Al, 25 cm. target-skin distance. The quality of the radiation may be expressed as a half-value layer of 4.3 mm. of aluminum. Treatments were given three times a week, which means that the total treatment usually took a month. As previously mentioned, the intravaginal treatments were given simultaneously with divided-dose external roentgen therapy and were followed by the intracervical application of radium.

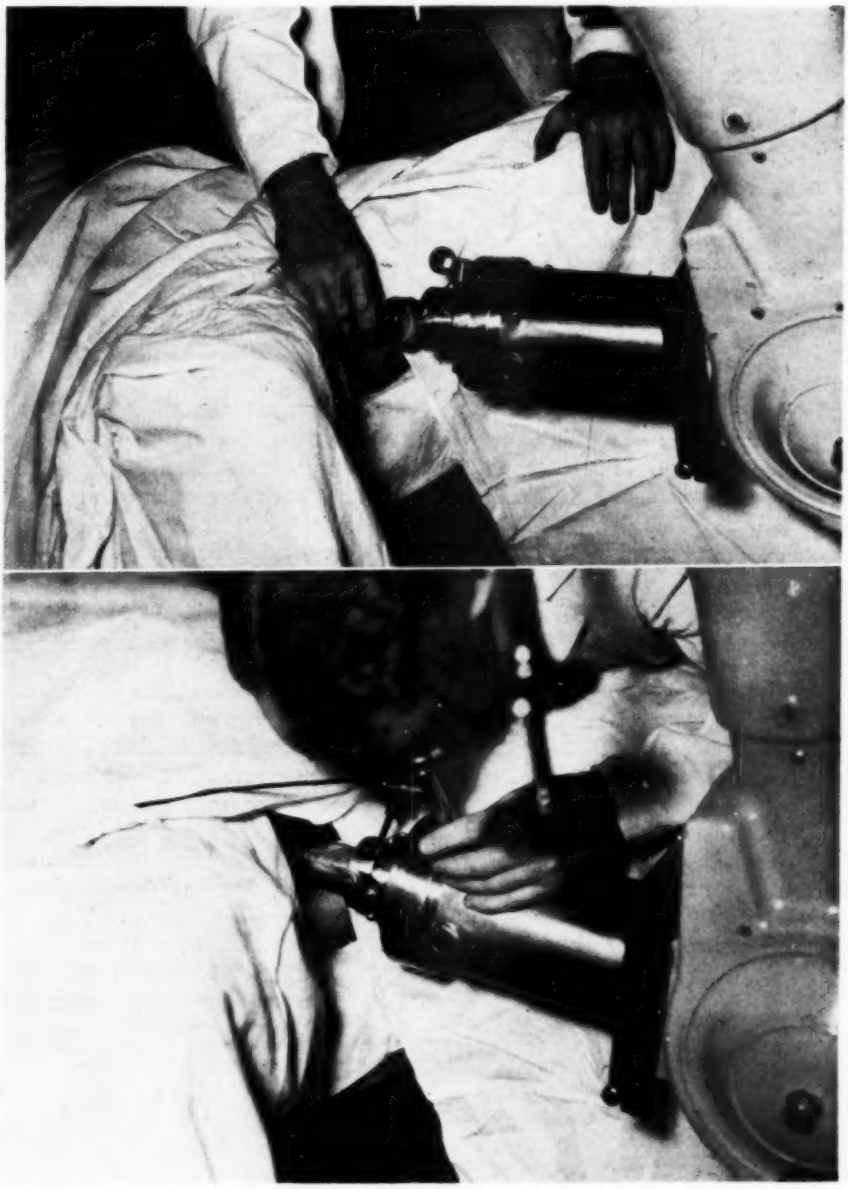


Fig. 4. Attaching intravaginal cone to master cone. The position of the intravaginal cone is carefully maintained.

Fig. 5. Checking position of intravaginal cone with periscope just before treatment.

In 1945, routine treatment was stepped-up in the following way: cancers limited to the cervix, or cervix and parametria, League of Nations Stages I and II, were still treated on the low-voltage machine, but the kilovoltage was raised to 130, the filter changed to 0.1 mm. of brass plus 0.25 mm. Al, giving a half-value layer of 5 mm. Al. The total number of treatments was increased to five per port, making a dose of

3,750 r to the fornices and 2,500 r to the cervix direct. The late Stage II cases received 750 r × 5 directly to the cervix, 3,750 r.

Cases of Stages III and IV were treated on the high-voltage (250-kv.) machine at 55 cm. target-skin distance, with 1.5 mm. Cu filtration, the half-value layer being 2 mm. Cu. The master cone used and the 3-cm., 3.5-cm., and 4-cm. cones and obturators are pictured in Figure 1. The position of the cone just before treatment was begun was checked by means of a periscope-like instrument shown in Figs. 1 and 5, which allows one to look directly down the inside of the cone. Details of the insertion of the cone, and its positioning and attachment to the machine, are illustrated in Figures 2–5.

With the 250-kv. machine used in advanced cases, all three vaginal ports received 750 r × 5, or 3,750 r. An occasional case with palpable disease in large quantity on one side was given as much as 4,500 r to that area.

Since 1946, treatments have been gradually increased in amount, so that now most patients are treated on the 250-kv. machine and receive 4,500 r to three ports and occasionally as much as 5,000 r. The tendency has been to use the same size cone in treating the cervix and the parametria, which means that the 3-cm. or 3.5-cm. size has been most commonly employed.

## THEORETICAL ADVANTAGES AND DISADVANTAGES OF THE METHOD

The use of intravaginal cones for roentgen therapy in cancer of the cervix has three obvious advantages: it gives a more uniform distribution of radiation than does radium, and gives it directly to the lesion without passing it first through normal tissues which soften the quality and diminish the quantity; it irradiates quite effectively the parametrial tissues and the pelvic lymph nodes; and it can be directed in such a fashion that the irritation and permanent changes produced in the bladder and rectum by large quantities of external roentgen therapy are avoided to a great extent.

Frequently, when treating cancer of the cervix with radium, one sees cases in which failure to cure can be attributed directly to inadequate irradiation of some portion of the growth. When radium or radon is placed in the cervical canal, the influence of the inverse-square law means that a necrotizing or near-necrotizing dose about the applicator may hardly affect tumor growing as much as 5 cm. away. When the source of irradiation is 55 cm. away from the tumor, the dose in the tissues does not fall off with anything like the rapidity seen with contact application. This fact is illustrated in Figure 6, a depth dose chart for the type of treatment used in 1943 and 1944, and Figure 7, a similar chart for 250-kv. rays at 55 cm. target-skin distance, using maximum doses.

That a large dose may actually be delivered to those pelvic lymph nodes most frequently involved by cancer metastatic from the cervix is shown by the case illustrated in Figures 8 and 9. This patient had a growth classified as League of Nations Stage III. When external roentgen therapy, intravaginal cone treatments, and intracervical radium had been used, it was decided to carry out a bilateral retroperitoneal pelvic lymph node dissection as described by Nathanson. This was done at two separate operations without any untoward results. When the nodes had been removed on each side, the area occupied before removal by the iliac group was marked by a single silver clip of the type so commonly used in neurosurgery. The bifurcation of the common iliac artery, the site of the so-called hypogastric node or group of nodes, was marked with two clips, while the area from which the obturator nodes had been dissected received three clips. When the patient had completely recovered from this procedure, she was taken to the radiographic department, an intravaginal cone was inserted as though to give treatment, and the pictures reproduced here were obtained. It is apparent at once that these important node-bearing

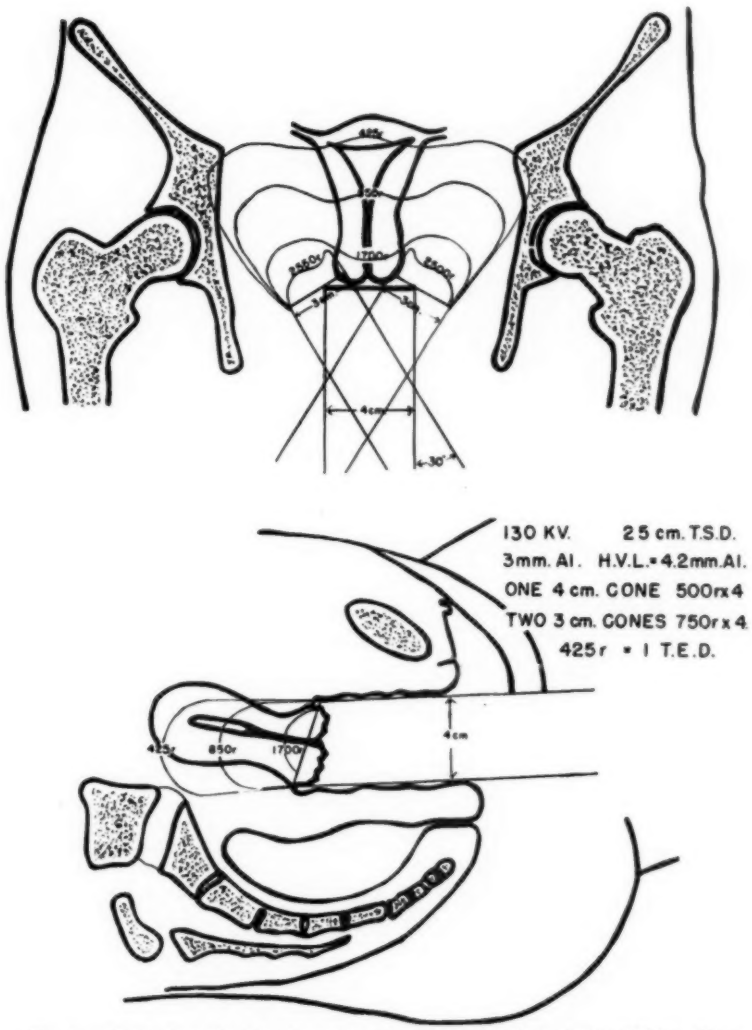



Fig. 6. Depth dose chart for type of treatment given in 1943–1944: 120 kv., 25 cm. target-skin distance, 4.3 mm. Al half-value layer, 500 r × 4 directly to the cervix, 750 r × 4 to each fornix.

areas lie for the most part in the direct beam of the vaginal irradiation.

Assuming 750 r × 6 at 250 kv., half-value layer 2 mm. Cu, 55 cm. target-skin distance, through a 3.5-cm. cone, to be given in this case, one can easily calculate that the single clip would get 1,500 tissue roentgens, the double clip 750, and the triple clip 1,500.

While various methods of external pelvic irradiation have been devised to minimize the dose given to the bladder and rectum, all result in considerable reaction in these organs. The therapy beams are not sharply defined in the tissues and, if the cervix and parametria are to receive full dosage, the anterior wall of the rectum and the floor of the bladder must of necessity receive an equal or nearly an equal amount. This does not occur with the use of intravaginal cones, where the beam can be accurately directed to treat the cervix, parametria, and pelvic lymph nodes and largely avoid the bladder and rectum.

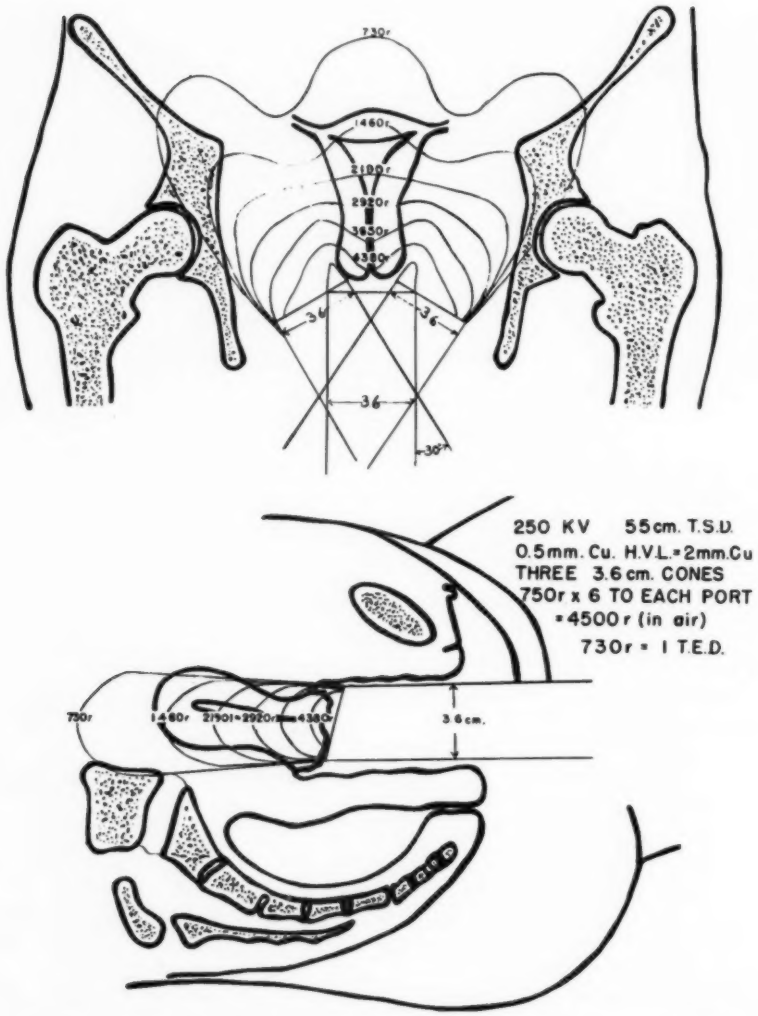
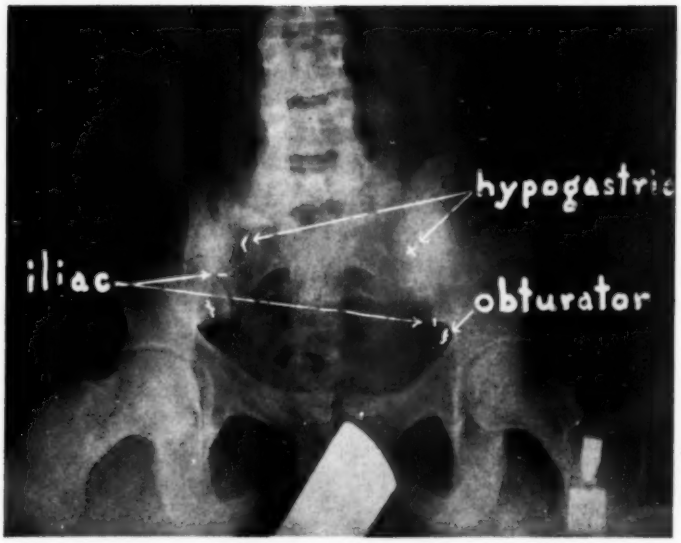
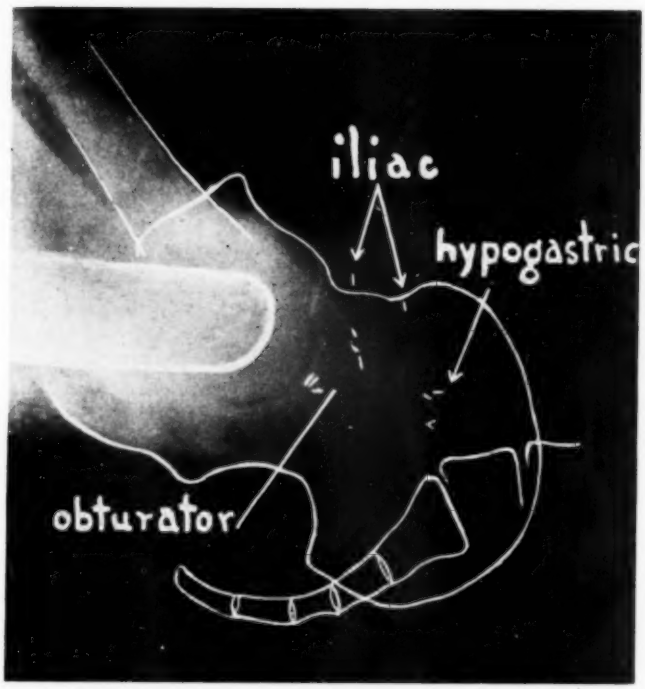



Fig. 7. Depth dose chart for type of treatment frequently used at present: 250 kv., 55 cm. target-skin distance, 2 mm. Cu half-value layer, 750 r × 6 to cervix and each fornix.

In the early cases treated by us, the cone was directed backward in the axis of the vagina, a procedure which irradiated the rectum and resulted in rectal irritation with tenesmus, diarrhea, excessive mucus, and often later rectal bleeding. Tipping the cone to the horizontal plane, so that it points at the level of the sacral promontory, *i.e.*, parallel with the long axis of the patient's body as she lies on the treatment table, has decreased or eliminated these symptoms completely.

Many roentgenologists in discussing the use of intravaginal cones with us have pointed out the fact that if one treats three fields, as we do, overlapping of ports is very difficult, if not impossible, to avoid. Admittedly this is so, though by aiming the middle cone directly at the cervix, putting the open ends of the lateral cones into the fornices, and checking every application both by looking down the cone after putting it into position and before attaching it to the treatment machine,




Figs. 8 and 9. Relation of intravaginal cone to the principal groups of pelvic lymph nodes—anteroposterior and lateral views. Note that the beam of radiation points at these nodes when the cone is aimed just anterior to the sacral promontory.

with a light, and by looking down the center of the cone, after it has been locked in place on the machine, with a lighted periscope, we attempt to avoid overlapping as much as possible. From the point of view of experience, however, such overlapping does not seem to produce any harmful result. Clinically, 4,500 r given to three ports may produce a fairly acute erythema and mucositis of the upper end of the vagina, but we have yet to see any necrosis due to this means alone. There is some evidence to suggest that higher doses, particularly when combined with radium in the cervical canal, may be dangerous.

## RESULTS

Intravaginal roentgen therapy in our clinic was designed to replace the use of the intravaginal radium bomb. Consequently all cases have received, in addition, external pelvic irradiation and intracervical radium or radon. The rather logical idea of treating cancer of the cervix by intravaginal roentgen therapy alone has occurred to us many times and has been suggested repeatedly by physicians working in the treatment department, but has not been tried except inadvertently. This is largely because our clinical material has been used quite systematically to compare one form of treatment with another. In 1943–44 (16), as already explained, intravaginal cones were compared with parametrial needles, external therapy and intracervical radium being kept constant. Since then the combination of intravaginal cones, external therapy, and intracervical radium, the best radiation method we have found so far, has been compared systematically with radical surgery. One case, however, gives clear evidence of what may be accomplished by intravaginal therapy alone.

A mentally limited Negro patient came to the Memorial Hospital on May 1, 1946, because of vaginal bleeding. Examination of the cervix showed a papillary friable lesion involving the entire cervix and thought to extend somewhat into the right fornix. Biopsy showed epidermoid carcinoma, Grade II. It was decided to treat her by radical hysterectomy, but previous to this operation four intravaginal treatments of 500 r each were given, the factors being 130 kv., 25 cm. target-skin distance, with a filter of 0.1 mm. brass and 0.25 Al, half-value layer 5 mm. aluminum. The 4-cm. cone was used. The purpose of this treatment was to clear up somewhat any infection which might be present in the cervix previous to radical surgery. The treatment extended from May 2 to May 13, 1946. Vaginal bleeding ceased and the patient decided she was well and left to visit relatives in Detroit. All attempts to learn of her whereabouts were fruitless.

On Oct. 2, five months later, the patient returned to the city and to the clinic, where examination showed a grossly normal cervix. On inspection, every vestige of carcinoma had disappeared, but two areas failed to stain with Lugol's solution. A radical hysterectomy was performed and multiple sections were removed from the cervix for detailed histologic study. In the unstained areas of the cervix, intraepithelial carcinoma was found. In only one section could minimal beginning invasion of the underlying tissues be seen.

We have here, then, a clinically obvious carcinoma of the cervix made to regress to a point where it could be diagnosed only by careful microscopic study. This was accomplished by the use of a very small amount of intravaginal radiation therapy.

The results of this type of therapy combined with radium are illustrated by the 113 cases in Group A treated in 1943–44, of which 104 have been followed for three years or longer. The three-year end-results for this group are given in Table I, from which it is seen that 36.5 per cent were alive and free of detectable cancer at three years. Three-year cure rates from this clinic for the years 1932 to 1937 inclusive, as published by Healy and Twombly in 1943, may be used for comparison. According to these figures, 36.1 per cent to 30.2 per cent of patients treated by vaginal bomb, radium, and external pelvic roentgen therapy were free of disease at three years. Evidently replacing the bomb with intravaginal irradiation has increased the cure rate in our material so far as one may judge from these statistics, though mathematically the difference is not statistically significant.

Lest it be thought that the nine cases omitted from this table might make a difference in the cure rate, it may be pointed out that if they are recorded as being the

TABLE I: RESULTS OF INTRAVAGINAL ROENTGEN THERAPY IN CARCINOMA OF THE CERVIX UTERI

| | All Stages | Stage I | Stage II | Stage III | Stage IV |
|---|---|---|---|---|---|
| Total cases | 104 (100%) | 27 (26%) | 40 (38.5%) | 29 (27.9%) | 8 (7.7%) |
| Lost under 3 years | 8 (7.7%) | 1 (3.7%) | 5 (12.5%) | 2 (6.9%) | 0 |
| Dead under 3 years | 54 (51.9%) | 5 (18.5%) | 17 (42.5%) | 24 (82.8%) | 8 (100%) |
| Alive at 3 years without carcinoma | 38 (36.5%) | 19 (70.4%) | 17 (42.5%) | 2 (6.9%) | 0 |
| Alive at 3 years with carcinoma | 4 (3.8%) | 2 (7.4%) | 1 (2.5%) | 1 (3.4%) | 0 |

same at thirty-six months as they were at their most recent follow-up, a reasonable assumption since in no case was this more than four months distant, the three-year cure rate would be 38.1 per cent.

## DISCUSSION

Frequently it seems that when one undertakes a new problem or works on what appears to be an original line of research, many others are found to be working simultaneously on the same problem or to have the same idea. In 1943, when we began intravaginal roentgen therapy we could find articles by only five authors who described this form of treatment (1, 4, 10, 11, 18). In contrast to this is a recent single issue of RADIOLOGY in which there appeared four formal articles on the subject (3, 14, 15, 19), while another included a brief reference to it (9), and a discussant of one of the papers gave detailed calculations on tissue dosage resulting from overlapping of fields when intravaginal cones are used (5). It seems that the method appeals to many as a simple and logical one if modern shockproof therapy machines are available. That most of these investigations are either limited in numbers or recent in origin is evidenced by the almost complete lack of figures as to the results obtained. It is in the light of this scarcity of statistics that we have ventured to set forth three-year end-results in our series, particularly as we are fortunate enough to have previous three-year series from our own clinic with which to compare them.

At a recent scientific meeting, four reputable experts presented their five-year results for the treatment of cancer of the uterine cervix. Their salvage rate varied from 19 to 55 per cent and it became evident from close attention to their papers and from conversation with them afterward that these tremendous variations could not be ascribed to inadequacy or perfection of technic, but was rather to be explained very largely by the type of clinical material with which each was confronted. A large number of early cases means a high five-year cure rate. Cases falling into the League of Nations Stage III and IV classification are often incurable by any known technic. We would urge in this connection the use of comparable series of cases *in the same clinic* for comparison of different methods of therapy wherever the volume of patients makes this possible. To compare results obtained in one clinic with those in another seems to lead only to skepticism about results on the part of the investigators, and fails to advance appreciably our scientific knowledge.

On reviewing the last five years experience with intravaginal therapy, it seems a pity that in at least a few cases a trial has not been made with cones and external ports alone, omitting intracervical radium. The addition of radium in the cervical canal cuts down the amount of therapy that can be given through cones because it causes localized over-irradiation and necrosis in the center of the field. Once necrosis starts, it is apt to spread in heavily irradiated tissues, as all radiotherapists are aware. Del Regato (15) has relied on external and intravaginal therapy alone in a small series of 52 cases and reports 22 alive and without evidence of cancer at three years, a 42 per cent salvage rate. Again, without knowing the type of material he treats or what he has done with the same sort of material with radium, it is hard to assess the significance of this figure, but it indicates that cervical cancer in all proba-

bility can be cured by intravaginal and external pelvic roentgen therapy alone, without the use of radium.

Del Regato uses a single cone, the walls of which are not opaque to the therapy beam, feeling that thereby he gets more accurate placement of his beam and sufficient irradiation of the parametria. We would agree with Nolan and Stanbro (14), however, who have plotted out the distribution of radiation for twelve different arrangements of cones and doses, that the three-field method is more effective when uncombined with intracavitary radium.

Finally, it may be pointed out that among our patients the only cases in which we thus far have three-year results were treated with what has proved to be minimal dosage: 120 kv., 4.3 mm. Al half-value layer; 3,000 r to each lateral port and 2,000 r to the cervix direct. At present many cases are getting twice the dose in tissue roentgens: 250 kv., 2 mm. Cu half-value layer, 4,500 to 5,000 r to each of three ports. Patients seem to stand this amount of therapy well, and the clinical impression is that the tumor regresses favorably. Time alone will tell whether or not the increased dose has added anything to the cure rate.

## SUMMARY

1. In 1943, at the Memorial Hospital, roentgen therapy of cancer of the cervix uteri through intravaginal cones was begun as a substitute for intravaginal radium application in a "bomb" placed against the cervix. During 1943 and 1944 four treatments of 500 r each were given to the cervix directly and four treatments of 750 r to each vault, the cones being angled outward 30°. The factors used were 120 kv., 25 cm. target-skin distance, half-value layer 4.3 mm. aluminum. Each case received in addition external pelvic radiation therapy and the application of a tandem of radium in the cervical canal for 3,000 mc. hr. One hundred and thirteen cases were so treated.

2. One hundred and four patients have been followed three years or longer or are dead or lost. Thirty-eight or 36.5 per cent of these are alive and apparently free of cancer. This three-year salvage is as good or better than previous three-year figures obtained with other forms of therapy in this clinic.

3. Experience has shown that intravaginal cone therapy can be increased in quantity considerably over the above amounts, external therapy and radium dosage being kept constant. At present patients are receiving 750 r × 6 to each of three vaginal fields, the factors being 250 kv., 55 cm. target-skin distance, and 2 mm. Cu half-value layer. No immediate ill effects have been noted from these higher doses and the response of the tumor seems favorable.

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## SUMARIO

### La Roentgenoterapia Intravaginal en el Cáncer del Cuello Uterino

En 1943, en el Hospital Memorial de Nueva York, inicióse la roentgenoterapia del cáncer del cuello uterino en forma de conos intravaginales, como sustituto de la aplicación intravaginal de radio en una "bomba" colocada contra el cuello. Durante 1943 y 1944 se administraron directamente al cuello cuatro tratamientos de 500 r y cuatro tratamientos de 750 r a cada bóveda, formando los conos ángulos de 30° hacia fuera. Los factores utilizados fueron: 120 kv., distancia foco-piel de 25 cm., capa de hemirreducción de 4.3 mm. de aluminio. Cada caso recibió además radioterapia pelviana externa y la aplicación de un tándem de radio en el conducto cervical durante 3,000 mc.-horas. Ciento trece casos en conjunto fueron tratados en esa forma.

Ciento cuatro enfermas han sido mantenidas en observación tres años o más o han muerto o sido perdidas de vista. Treinta y ocho, o sea 36.5 por ciento, se hallan vivas y aparentemente sin cáncer. Este rescate de tres años es igual o mejor que las previas estadísticas trienales obtenidas con otras terapéuticas en esta clínica.

La experiencia ha demostrado que la conoterapia intravaginal puede ser aumentada en cantidad considerablemente sobre las cifras anteriores, sin modificar la terapéutica externa ni la dosis de radio. En la actualidad las enfermas reciben 750 r × 6 en cada uno de tres campos vaginales, con los siguientos factores: 250 kv., distancia foco-piel de 55 cm. y capa de hemirreducción de 2 mm. de Cu. No se han observado efectos contraproducentes inmediatos con estas dosis mayores y la respuesta del tumor parece favorable.

# Review of Ten Years Experience with Transvaginal Roentgen Therapy[1]

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IT WAS MY PRIVILEGE to be an associate of the late Dr. E. A. Merritt when, in October 1936, his interest in the application of roentgen rays directly to the cervix was renewed. Merritt (1) had attempted this procedure in 1921 but was forced to abandon the project due to the dangers inherent in non-shock-proof apparatus.

The material for the study to be reported here consists of cases referred by the Staff of the Warwick Clinic, by the Garfield Hospital, and private cases referred to Dr. Merritt or myself. This paper is an analysis of our experience with transvaginal roentgen therapy from October 1936 through December 1946. The transvaginal approach, either alone or in combination with other conventional methods, was employed in 346 cases of carcinoma of the cervix during that time; 202 cases were treated prior to 1943 and are thus available for analysis in terms of five- to ten-year survivals. Nine cases are untraced at present and are not included in the survival analysis. Definitive survival data are available for 192 cases. All cases are histologically proved.

The cases are grouped clinically in accordance with the League of Nations classification as modified in 1937. Eighty-nine patients are living as of September 1947. The survival data by years are as follows:

| | No. of Cases | | | | | |
|---|---|---|---|---|---|---|
| | 10 yr. | 9 yr. | 8 yr. | 7 yr. | 6 yr. | 5 yr. |
| Stage I | 8 | 7 | 4 | 3 | 12 | 14 |
| State II | 4 | 3 | 2 | 4 | 15 | 7 |
| State III | 0 | 1 | 3 | 0 | 1 | 1 |
| Stage IV | 0 | 0 | 0 | 0 | 0 | 0 |

Inasmuch as no routine technic has been followed during the years covered by the study, the cases have been analyzed and placed in various categories depending upon the method or combination of methods by which the primary treatment was given. There are six different categories as follows:

1. *Transvaginal therapy only.* It is only fair to state that many patients in this group received small daily doses of external radiation (50–100 r) for seven to fourteen days prior to the intensive treatment, in an attempt to improve the local and general condition. This has since been abandoned. I feel that it contributed in no way to the control of the disease.

2. *External roentgen therapy supplemented by transvaginal roentgen therapy.*

3. *External roentgen therapy supplemented by transvaginal roentgen therapy plus intrauterine and intracervical radium therapy.*

4. *External roentgen therapy supplemented by transvaginal roentgen therapy, plus radium applied locally to the cervix.* The radium in this group of cases probably contributed very little to control of the disease. It was given for the most part in small doses (1,200 mg. hr.) to control hemorrhage, prior to institution of the primary treatment.

5. *Transvaginal roentgen therapy plus intracavitary radium.*

6. *Transvaginal roentgen therapy plus local radium.* The radium in this instance was again used, as in 4, to control the bleeding.

The survival rate by clinical stages, ac-

[1] Presented at the Thirty-third Annual Meeting of the Radiological Society of North America, Boston, Mass., Nov. 30–Dec. 5, 1947.

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TABLE I: SURVIVAL RATES FOR 192 CASES OF CARCINOMA OF THE CERVIX

| Method | Stage I | | | Stage II | | | Stage III | | | Stage IV | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total Cases | Cases 5–10 yr. | Survivals 5–10 yr. | Total Cases | Cases 5–10 yr. | Survivals 5–10 yr. | Total Cases | Cases 5–10 yr. | Survivals 5–10 yr. | Total Cases | Cases 5–10 yr. | Survivals 5–10 yr. |
| Transvaginal only | 42 | 28 | 21 (75%) | 15 | 9 | 1 (10%) | 6 | 3 | 0 | | | |
| External plus transvaginal | 53 | 23 | 13 (56%) | 99 | 53 | 20 (37%) | 49 | 17 | 5 (31%) | 6 | 4 | 0 |
| External plus transvaginal plus intrauterine radium | 2 | 2 | 2 (100%) | 23 | 13 | 7 (53%) | 5 | 3 | 0 | | | |
| External plus transvaginal plus local radium | 6 | 5 | 4 (80%) | 15 | 11 | 5 (45%) | 4 | 2 | 1 (50%) | | | |
| Transvaginal plus intrauterine radium | 11 | 11 | 6 (54%) | 6 | 3 | 2 (66%) | 1 | 1 | 0 | | | |
| Transvaginal plus local radium | 3 | 3 | 2 (66%) | 1 | 1 | 0 | | | | | | |
| TOTAL | 117 | 72 | 48 (66%) | 159 | 90 | 35 (38%) | 65 | 26 | 6 (23%) | 6 | 4 | 0 |

cording to the method of treatment, is shown in Table I.

### CARCINOMA OF THE CERVICAL STUMP

Fourteen of the 192 cases represent carcinoma developing in the cervical stump following supravaginal hysterectomy. Of these 14 patients, 10 (71 per cent) have lived from five to ten years. Three died of the disease, one after five years survival. One died of carcinoma of the breast and another of carcinoma of the ovary before five years had elapsed.

Seven patients received transvaginal roentgen therapy only; 6 (85 per cent) are living and well for five years or longer.

### ABSOLUTE SURVIVALS

The survival data in Table I do not include 60 cases that were treated during the same interval by other means. The analysis of this group is not complete. It consists of 5 cases of Stage I, 15 of Stage II, 19 of Stage III, and 21 of Stage IV. Treatment was by external roentgen irradiation or radium therapy, alone or in various combinations. This group will undoubtedly prove to be the group in which transvaginal therapy could not be practicably administered, due to the advanced stage of the disease or local conditions in the genital tract which would preclude the introduction of a speculum. From incomplete data available at present, I believe that not more than four of the total number will be classed as five-year survivals.

The *absolute five-year survival rate* for the entire group of cases (262) treated between October 1936 and Jan. 1, 1943, counting all untraced cases as dead, is 35 per cent.

### ANALYSIS OF DEATHS

Of the 192 patients receiving transvaginal roentgen therapy prior to 1943, 118 are dead, 104 having died prior to five years of observation. Of the 104 who failed to survive five years, 2 died between the fourth and fifth year without clinical evidence of the disease. It is known that at least 67 patients died of, or with, the disease. The cause of death in the remaining cases is not known.

Fourteen deaths occurred after five years, 5 from causes other than cancer, 6 from causes unknown, and 3 from cancer.

The average longevity by stages in those cases that did not survive the five-year period is as follows:

| | | |
|---|---|---|
| Stage I: | 20 cases | 23 mo. |
| Stage II: | 48 cases | 19 mo. |
| Stage III: | 18 cases | 15½ mo. |
| Stage IV: | 4 cases | 9 mo. |

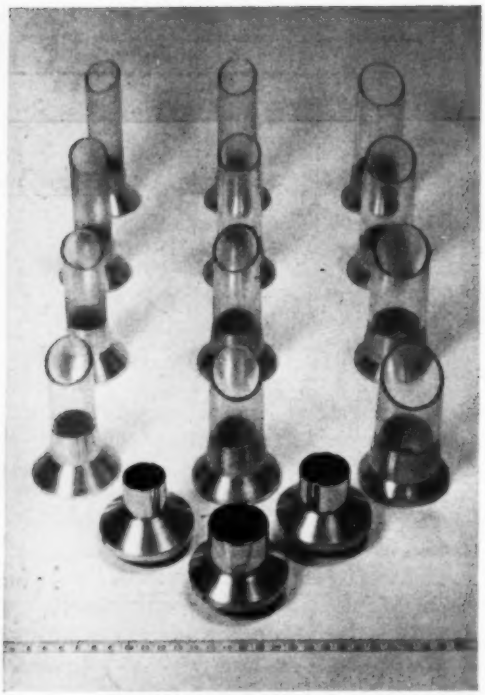

Fig. 1. Complete set of specula and master cones.

TECHNIC OF TREATMENT

The patient is placed in the lithotomy position, and a modified Ferguson speculum of suitable dimensions, with walls as nearly transparent to roentgen rays as possible, is introduced, exposing the cervix at the distal open end. The longest and largest speculum that can be introduced into the vagina is used. The majority of patients can accommodate specula 3.8 to 4.2 cm. in diameter. The shortest anode-cervix distance practicable, consistent with adequate protection at the introitus, is utilized. By combining a short anode-cervix distance with a large speculum and large master cone aperture, the maximum divergence of the beam at the level of the cervix is obtained. This results in a larger irradiated field and a greater depth dose. No effort is made to direct the beam into either of the fornices or the parametria. The sole aim is to irradiate uniformly the cervix, fornices, and pericervical tissues, including that portion of the parametria immediately adjacent to the cervix, as well as possible.

Two pieces of apparatus have been employed. One machine operates at 140 kv. (peak), 8 ma., 3 mm. Al filter (added), half-value layer 3.85 mm. Al. The anode-cervix distance varies from 24 to 28 cm., and the diameter of the irradiated field from 5 to 6 cm. The other machine operates with the following factors: 220 kv. (peak), 20 ma., 0.5 mm. Cu filter (added), half-value layer equivalent to 1.0 mm. Cu, anode-cervix distance 37 to 41 cm. The diameter of the irradiated fields measures from 4.5 to 6 cm.

The anode-cervix distance and the size of the irradiated field vary with the length and diameter of the speculum and the diameter of the master cone aperture.

Daily doses of 800 r are given. The treatment time varies from eight and a half to fourteen minutes. The total dose has varied over the years from 5,000 to 8,000 r. The development of a higher percentage of untoward reactions in the vaginal vault and extensive vaginal atresia with the latter figure indicate that a smaller total dose is desirable. At present, a total dose of 6,400 r is given if intracervical and intrauterine radium is to be added, and 7,200 r if supplementary radium therapy is not to be given.

The transvaginal roentgen therapy is given at the beginning of the course, concomitant with the external roentgen therapy, *i.e.*, on the first eight or nine treatment days, the patient receives both an external and transvaginal treatment. At present, the entire course of roentgen therapy requires a minimum of forty-six days, during which time a total dose of 12,000 r (measured with back-scatter) is administered externally through four pelvic fields. The intracervical and intrauterine radium is given as soon as possible after completion of the external roentgen therapy.

I cannot be certain as to whether rays generated at 220 kv.p. or 140 kv.p. are most desirable. Until the year 1943, all of the treatment was given at 220 kv.p. Since that time, a portion of the treatment

in each case has been given at 140 kv.p. and the remainder at 220 kv.p.

The 140-kv.p. apparatus has the advantage of increased flexibility and a shorter anode-cervix distance with larger fields at the cervical level. The advantages of the 220-kv.p. apparatus are: a longer anode-cervix distance and a beam of shorter wave length. Theoretically, this should give a greater depth dose at the cervical level. This advantage, however, is probably offset by a smaller irradiated field. I am inclined to believe that conventional apparatus operating in the 140-kv.p. range is adequate and preferable to the more cumbersome 220-kv.p. apparatus. Attention is called, however, to the fact that the survival data herein presented are based on transvaginal roentgen therapy delivered at 220 kv.p.

### DESCRIPTION OF SPECULA[3]

Since December 1947 a new type of speculum has been used in all cases. To date this type of speculum and master cone has been most satisfactory and has obviated all the disadvantages inherent in the design previously used. Figure 1 is a photograph of the completed set of specula together with the master cones. The speculum consists of a flanged collar made of aluminum, to which a plastic lucite tubing is inseparably attached. The lucite tubing has the advantage over bakelite or hard rubber in that there is little, if any, absorption in the walls, as determined in actual measurement. These specula are made in three different diameters, to accommodate the three different sizes of master cones, and in four different lengths. With specula of this type, almost every size and shape of vagina can be treated with anode-cervix distances varying from 22 to 25 cm.

The master cones (Fig. 2) consist of lead-lined tubing, with an inside diameter of 2.5, 3.0, and 3.5 cm., respectively. They can be readily detached from the base plate of the tube-head and are easily inserted into the specula, so that the free end protrudes 3 cm. inside the introitus. This accomplishes two purposes: (*a*) Complete and adequate protection at the introitus is obtained, thus overcoming one of the most undesirable features of our earlier technic. (*b*) A stable articulation between the master cone and the speculum is made, which eliminates the danger inherent in slight change in the position of the patient, with consequent alteration of the relationship between the master cone and the speculum. The divergence of the beam is such that fields varying from 4.3 to 6.2 cm. at the level of the cervix are treated, depending upon the size of the master cone and the length of the speculum. All of the transvaginal treatment is now given at 140 kv.p., 5 ma., 3 mm. aluminum filter, and an anode-cervix distance varying from 22 to 25 cm., depending upon the length of the vaginal canal and the size of the speculum used. The dosage factors are the same as described in the preceding section of this paper.

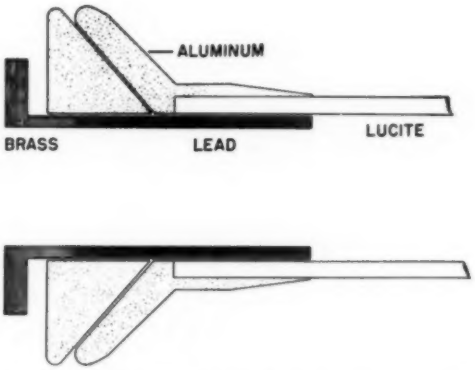


Fig. 2. Cross-section detail of master cone in articulation with the speculum.

The various steps in introducing the specula into the vagina and the method of articulating the master cone with the speculum are shown in Figure 3. The use of an inflated Hagner bag in place of a fixed obturator for each type of speculum makes the apparatus much less expensive and is entirely satisfactory. After completion of the treatment, the specula are sterilized by soap and water and then immersed in

[3] Not included in the paper as originally presented. Submitted for publication in October 1948.

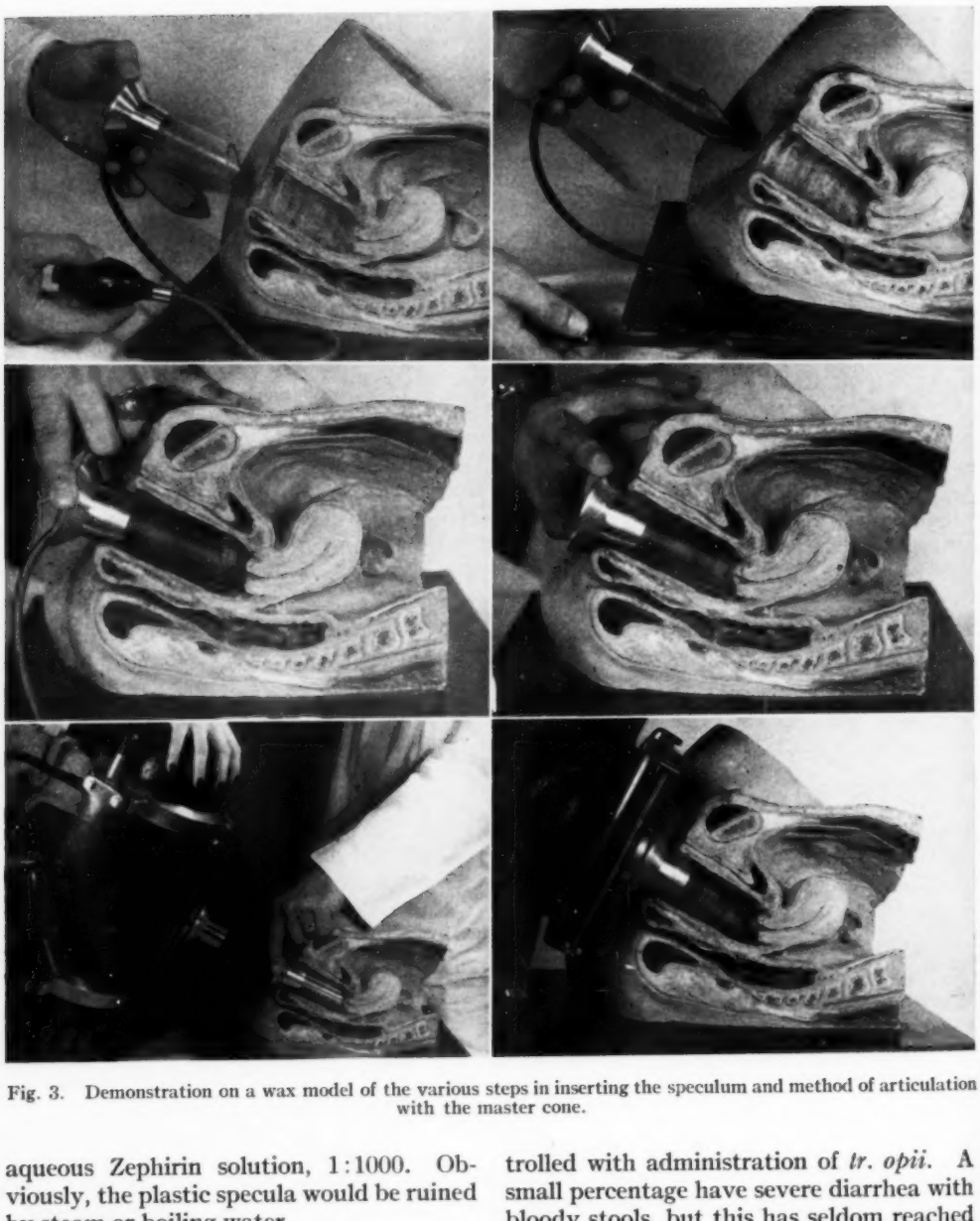

Fig. 3. Demonstration on a wax model of the various steps in inserting the speculum and method of articulation with the master cone.

aqueous Zephirin solution, 1:1000. Obviously, the plastic specula would be ruined by steam or boiling water.

## COMPLICATIONS

All patients have some degree of diarrhea as an immediate result of the transvaginal therapy. This is mild in a few cases. In a majority, it is moderately severe, lasting seven to fourteen days, but is easily controlled with administration of *tr. opii*. A small percentage have severe diarrhea with bloody stools, but this has seldom reached alarming proportions and is eventually brought under control.

Immediate bladder irritation has in the vast majority of cases been mild. In only a few has there been severe cystitis with hematuria.

The percentages of late complications,

with the disease apparently under control at the time, and of complications directly attributable to radiation effects on normal tissue, are as follows:

| | | |
|---|---|---|
| I. | Late bowel reaction. | |
| | Moderate severity | 4.0% |
| | Severe | <1.0% |
| | Rectovaginal fistula | 1.7% |
| II. | Bladder | |
| | Severe | <1.0% |
| | Vesicovaginal fistula | 0 |
| III. | Local necrosis | |
| | Moderately severe | 1.4% |
| | Severe | 1.0% |
| IV. | Vulvar and/or vaginal necrosis | |
| | Moderately severe | 4.0% |
| | Severe | 3.4% |
| V. | Vaginal atresia | |
| | Partial | 21.0% |
| | Complete | 5.0% |

I believe that this represents a relatively low percentage of serious complications considering the number of cases treated and the intensive therapy that was given in order to control a lethal disease.

Two cases were seen with a severe bowel reaction which progressed to a complete stenosis, requiring colostomy. In only 6 cases did a rectovaginal fistula directly attributable to radiation develop, with the disease under control at the fistulous site. Numerous other rectovaginal fistulae were, of course, encountered, but always at the site of uncontrolled or recurrent carcinoma. In one case a severe bladder reaction developed, with death, so far as could be determined, from bladder hemorrhage, without evidence of cancer at the time.

Moderate or severe local necroses at the cervix, while often assuming alarming proportions, were always brought under control by conservative treatment. The vulvar and vaginal necroses were mostly the result of our efforts to develop specula that would give a maximum spread of the beam at the level of the cervix. This necessitated inadequate protection at the introitus. This complication has been almost entirely eliminated in our more recent cases, through the development of the specula described above. Some of the severe necroses of the vaginal walls were due to a large total dose of radiation. I refer to the dose of 8,000 r, which, as previously stated, is now considered excessive, particularly when a wide divergence of the beam is obtained.

Vaginal atresia, either partial or complete, I do not consider a real complication. As a matter of fact, some degree of cicatricial contraction in the apex of the vaginal vault can scarcely be avoided if these patients are to be treated adequately, and partial atresia, when it did occur, did so largely because there was intensive radiation in the fornices and vaginal cuff. It has long been known that this is one of the most difficult areas to irradiate adequately by any method. In reviewing the cases, one is constantly impressed with the efficacy of this method in controlling the disease that has invaded the fornices and proximal 1 to 2 cm. of the vaginal walls.

## DISCUSSION

It is difficult to explain many of the inconsistencies apparent in Table I. Many of the groups are far too small to indicate actual percentage trends. This study was not conducted as a controlled experiment. It must be realized that it required considerable fortitude to discard radium entirely, in the face of accumulated evidence of its effectiveness in the control of cervical cancer. At least three years had to elapse before we were convinced that the transvaginal approach had great potentialities.

Rigid criteria for selection of cases were not adhered to. The following general concepts obtained, however, in our selection of treatment:

1. *Transvaginal roentgen therapy only.*

(*a*) All early cases of Stage I (except endocervical cancer).

(*b*) All cases of Stage I in obese subjects (except endocervical cancer). The survival in this group is gratifying—21 of 28 cases (75 per cent). Three of the 7 who failed to survive died between the fourth and fifth year of causes other than cancer. Another died of carcinoma of the ovary after eleven months of survival.

(*c*) Selected cases of clinical Stage II, classed as such by virtue of extension on

the vaginal wall, with the uterus freely movable. This was obviously poor selection as indicated by a single survival in 9 cases. This group demonstrated satisfactory control of the local disease in the fornices, but paracervical and parametrial disease spread unhampered.

(*d*) Transvaginal therapy only was given in a few cases of advanced clinical Stage III to control bleeding. The possibility of permanent cure seemed hopeless.

2. *Supplementary intracavitary radium* was felt to be necessary in all cases of endocervical cancer, as we believed there was a greater chance of endometrial extension.

3. *Local radium application* was employed in order to control hemorrhage. This practice has been discontinued, as it has been found that transvaginal therapy alone will accomplish the same purpose more efficiently. If a vaginal pack is maintained and removed only to insert the speculum, the bleeding is well controlled within five to seven days. It is *imperative that the vagina be tightly packed through the speculum during treatment, to prevent severe hemorrhage during that time.*

4. *Supplementary external roentgen therapy* was given many times routinely when the above conditions prevailed and always when we felt that local measures were inadequate.

Why the percentage of five-year survivals in Stage I dropped to 54 per cent when external therapy was added is not clear. It is quite likely that this group included the majority of the more advanced cases of Stage I and perhaps many cases of early Stage II. Addition of external roentgen therapy in all cases would quite probably have improved the results.

The problem of accurate clinical classification is extremely difficult. The only way in which this error can be ameliorated, is the reporting of absolute survivals in terms of all cases treated.

It is obvious, from the foregoing discussion, that transvaginal roentgen therapy can be utilized to advantage in the treatment of cervical cancer. I consider it an ideal substitute for local cervical radium application in all cases where it can be practicably applied. In carcinoma of the cervical stump, I believe that it can supplant radium entirely.

The only possibility that I can see for improvement in the results herein presented is the delivery of larger doses to the parametria with higher-voltage apparatus and the routine addition of intracavitary radium therapy. This latter we are now using.

## SUMMARY

1. An absolute five-year to ten-year survival of 35 per cent was obtained in 262 unselected cases of carcinoma of the cervix.

2. Of this series of cases, 79 per cent received transvaginal roentgen therapy either alone or supplemented by radium and/or external roentgen therapy.

3. The technic of application is described.

4. Possibilities for improvement statistically are suggested.

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## REFERENCE

1. MERRITT, E. A.: Possibilities of Intra-vaginal X-ray Therapy with Description of Technique. J. Radiol. **2**: 29–34, 1921.

SUMARIO

**Repaso de Diez Años de Experiencia con la Roentgenoterapia Transvaginal**

En una serie de 262 casos de carcinoma del cuello uterino obtúvose un coeficiente global de 35 por ciento de sobrevivencias de cinco a diez años. Setenta y nueve por ciento de la serie total recibíeron la roentgenoterapia transvaginal ya sola o asociada a la irradiación roentgen externa o aplicación de radio, o a ambas. En 192 casos tratados transvaginalmente para los cuales había datos precisos sobre la sobrevivencia, los coeficientes de sobrevivencia de cinco a diez años, conforme al período clínico, fueron: Período I, 66 por ciento; Período II, 38 por ciento; Período III, 23 por ciento; Período IV, 0.

Entre 14 casos de carcinoma del muñón cervical consecutivo a una histerectomía supravaginal, hubo 10 sobrevivencias de cinco a diez años, 6 de ellas consecutivas a la irradiación transvaginal sola.

Los casos en que se basan las cifras anteriores fueron tratados con 220 kv. p., pero más recientemente el tratamiento ha sido con 140 kv., 5 ma., filtro de 3 mm. de aluminio y distancia ánodo-piel de 22 a 25 cm. El campo de irradiación tiene de 5 a 6 cm. de diámetro y la dosis total es de 6,400 r, con curieterapia intracervical o intrauterina suplementaria, o de 7,200 r, si no se emplea radio. La dosis diaria es de 800 r.

Aunque no se usó en la serie descrita, se describe un espéculo especial inventado recientemente, que consiste en un manguito de reborde fabricado de aluminio al cual va unido un tubo de lucita plástica. Utilízase con un cono maestro hecho de un tubo forrado de plomo y posee la gran ventaja de que proporciona protección adecuada en el introito.

El porcentaje de complicaciones graves consecutivas a la roentgenoterapia transvaginal ha sido relativamente bajo y la mayoría han sido cohibidas sin mayor dificultad. El método está considerado como sustituto ideal de la aplicación local de radio al cuello uterino en todos los casos en que puede emplearse prácticamente.

# Place of Deep External X-Ray Irradiation in the Treatment of Carcinoma of the Cervix by Long Element Needles[1]

GEORGE W. WATERMAN, M.D. and WILLIAM A. REID, M.D.

Providence, R. I.

THE PURPOSE OF this paper is to review our experience at the Rhode Island Hospital over a ten-year period, 1933–42, in order (1) to determine what effect deep x-ray therapy has had on five-year survival rates; (2) to ascertain the incidence of severe complications with radium alone and with radium plus x-rays; (3) to answer, if we can, the question as to whether x-rays should be used before or after radium treatment; (4) to determine what the interval between x-ray and radium should be; (5) to estimate the value of a lead shield externally over the lower abdomen as protection to the paracervical region against overdosage from x-rays.

The radium technic used in these cases has already been adequately illustrated and described in other publications. The x-ray therapy has been given by Drs. J. F. Boyd and Philip Batchelder of the Department of Radiology at the Rhode Island Hospital, the factors being 200 kv., 20 ma., target-skin distance 50 cm., filter 0.4 mm. Sn (Thoraeus). Two large fields, one anterior and one posterior, were used.

The material for this study is taken from a series of 433 cases (absolute) seen between 1933 and 1942. Of these

113 were treated primarily with radium needles alone
234 were treated primarily with radium needles plus x-rays

} Five-year survivals in 347 cases: 154 or 44.4%

49 were treated by other methods
21 had primary treatment elsewhere
16—far advanced cases, etc.—had no treatment

433 total cases seen

The absolute survival rate for the 433 cases was 168/433 or 38.8 per cent. The relative survival rate was 168/417 (433−16), or 40 per cent. The survival rate for the needle-treated cases, was 44.4 per cent.

TABLE I: CARCINOMA OF THE CERVIX: FIVE-YEAR SURVIVALS, 1933–42

| Primary Treatment | Cases | Survivals |
|---|---|---|
| *Operable Group (Schmitz I and II)* | | |
| Needles alone | | |
| Stage I | 12 | 11 (91.7%) |
| Stage II | 44 | 34 (77.3%) |
| TOTAL | 56 | 45 (80.4%) |
| Needles plus x-rays | | |
| Stage I | 5 | 5 (100%) |
| Stage II | 72 | 45 (62.5%) |
| TOTAL | 77 | 50 (64.9%) |
| *Inoperable Group (Schmitz III and IV)* | | |
| Needles alone | | |
| Stage III | 51 | 13 (25.5%) |
| Stage IV | 6 | 0 |
| TOTAL | 57 | 13 (22.8%) |
| Needles plus x-rays | | |
| Stage III | 131 | 44 (33.6%) |
| Stage IV | 26 | 2 (7.7%) |
| TOTAL | 157 | 46 (29.3%) |

This paper is concerned only with those cases treated primarily with radium, and with radium plus x-rays. In order to give a truer picture, comparisons between the two groups are made on a basis of similar clinical stages. The Schmitz classification has always been used by us. It has the advantage that its Stages I and II represent the "operable" or favorable group. This is the group that is now being reclaimed for treatment by some of our surgeons. Schmitz' Stage III and IV cases are "inoperable" and still purely radiological problems.

Table I, listing the five-year survivals, brings out a fact that seems rather surprising. In the operable or favorable group, 56 cases treated by interstitial ra-

[1] Presented at the Thirty-third Annual Meeting of the Radiological Society of North America, Boston, Mass., Nov. 30–Dec. 5, 1947.

TABLE II: CARCINOMA OF THE CERVIX: COMPLICATIONS IN CASES TREATED BY RADIUM ALONE AND RADIUM PLUS X-RAYS, 1933–42

| Primary Treatment | Cases | Urinary Tract | Intestinal Tract | Fistula | Inflammatory | Total |
|---|---|---|---|---|---|---|
| | | | *Operable Group* | | | |
| Needles alone | | | | | | |
| Stage I | 12 | 0 | 0 | 0 | 0 | 0 |
| Stage II | 44 | 3 | 3 | 0 | 0 | 13.6% |
| TOTAL | 56 | 3 | 3 | 0 | 0 | 10.7% |
| Needles plus x-rays | | | | | | |
| Stage I | 5 | 2 | 0 | 0 | 0 | 40.0% |
| Stage II | 72 | 4 | 6 | 5 | 0 | 20.8% |
| TOTAL | 77 | 6 | 6 | 5 | 0 | 22.1% |
| | | | *Inoperable Group* | | | |
| Needles alone | | | | | | |
| Stage III | 51 | 0 | 2 | 3 | 3 | 15.7% |
| Stage IV | 6 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 57 | 0 | 2 | 3 | 3 | 14.0% |
| Needles plus x-rays | | | | | | |
| Stage III | 131 | 1 | 6 | 6 | 3 | 12.2% |
| Stage IV | 26 | 0 | 1 | 2 | 0 | 11.5% |
| TOTAL | 157 | 1 | 7 | 8 | 3 | 12.1% |

*Incidence of Fistula*

| | Cases | Stage I | Stage II | Stage III | Stage IV | Total |
|---|---|---|---|---|---|---|
| Needles alone | 113 | 0 | 0 | 3 | 0 | 3 (2.7%) |
| Needles plus x-rays | 234 | 0 | 5 | 6 | 2 | 13 (5.6%) |

dium alone showed a five-year salvage of 45 cases, or 80.4 per cent. On the other hand, the salvage for the similar group of 77 operable cases treated by radium needles plus x-ray irradiation is only 64.9 per cent, a difference of 15.5 per cent in favor of radium alone. In the inoperable or unfavorable group—Stages III and IV—the opposite condition holds, with 22.8 per cent survival for the 57 cases treated by needles alone and 29.3 per cent for 157 cases receiving x-ray irradiation as well.

Table II shows the incidence of complications with the two types of treatment. This figure is seen to be markedly higher in the operable cases—Stages I and II—when x-rays were used, the incidence with the combined treatment being 22.1 per cent, or more than twice that with needles alone, 10.7 per cent. In the inoperable group—Stages III and IV—the gross incidence of complications did not vary so widely. Just as the survival rates were more favorable in cases receiving both radium and x-ray therapy, so the needles-plus-x-ray group showed fewer complications, 12.1 per cent as compared with 14 per cent when radium alone was used.

The incidence of fistula in cases treated by needles alone was 3 in 113, or 2.7 per cent, all the fistulas appearing in Stage III and IV cases. In the needles-plus-x-ray group the fistula incidence was 13 in 234, or 5.6 per cent. Five of these fistulas were in cases of Stages I and II, an incidence of 6.9 per cent for these two stages.

Table III shows the year-by-year progress in our attitude toward external x-ray therapy. In the first four years, 1933–36, 61 cases were treated with radium alone, while 77 were treated by radium plus x-rays. The rate of complications was 14 per cent for radium alone and 18 per cent for radium plus x-rays. In 35 cases x-ray therapy was given before radium application, with 17 per cent complications; in 42 cases x-ray irradiation followed radium treatment, with 19 per cent complications. The incidence of complications was thus about the same in both groups. In 1937 and 1938 x-ray therapy was given before radium application as a planned procedure, the

TABLE III: CARCINOMA OF THE CERVIX: COMPLICATIONS IN CASES TREATED BY X-RAYS BEFORE AND AFTER RADIUM

| Year | Total Cases | Treated by Needles Alone | Complications | Treated by Needles plus X-rays | Complications | Treated by X-rays Before Radium | Complications | Treated by X-rays After Radium | Complications |
|---|---|---|---|---|---|---|---|---|---|
| 1933 | 58 | 14 | 3 | 29 | 7 | 12 | 3 | 17 | 4 |
| 1934 | 40 | 17 | 2 | 20 | 4 | 7 | 2 | 13 | 2 |
| 1935 | 34 | 18 | 3 | 12 | 3 | 7 | 1 | 5 | 2 |
| 1936 | 44 | 12 | 1 | 16 | 0 | 9 | 0 | 7 | 0 |
| TOTAL | 176 | 61 | 9—14% | 77 | 14—18% | 35 | 6—17% | 42 | 8—19% |
| 1937 | 44 | 3 | 1 | 29 | 9 | 28 | 9 | 1 | 0 |
| 1938 | 43 | 3 | 0 | 35 | 6 | 34 | 6 | 1 | 0 |
| TOTAL | 87 | 6 | 1 | 64 | 15—23.3% | 62 | 15—24% | 2 | 0 |
| 1933–38 | 263 | 67 | 10—15% | 141 | 29—23% | 97 | 21—21.6% | 44 | 8—18% |
| 1939 | 36 | 4 | 0 | 28 | 2 | 9 | 1 | 19 | 1 |
| 1940 | 40 | 19 | 2 | 11 | 2 | 3 | 0 | 8 | 2 |
| 1941 | 37 | 6 | 0 | 24 | 2 | 3 | 0 | 21 | 2 |
| 1942 | 57 | 17 | 2 | 30 | 1 | 2 | 1 | 28 | 0 |
| 1939–42 | 170 | 46 | 4—9% | 93 | 7—7.5% | 17 | 2—11.8% | 76 | 5—6.5% |
| TOTAL | 433 | 113 | 14—12.4% | 234 | 36—15.4% | 114 | 23—20% | 120 | 13—10.8% |

TABLE IV: CARCINOMA OF THE CEVIX: EFFECT OF INTERVAL BETWEEN RADIUM APPLICATION AND X-RAY THERAPY ON COMPLICATIONS, 1933–42

| Interval in Weeks | Number of Cases | Complications |
|---|---|---|
| 0–4 | 94 | 21 (22.3%) |
| 5–8 | 62 | 7 (11.3%) |
| 9–12 | 34 | 3 (8.8%) |
| 12+ | 44 | 5 (11.4%) |

usual interval being one month. In these two years 64 cases were treated by radium plus x-rays and in 62 of these the x-ray treatment was preliminary to radium application. This procedure was attended by a complication incidence of 24 per cent.

A reaction against this excessive complication rate makes itself apparent in the increased number of cases treated by radium alone in 1940 and by the shift from *before* to *after* as far as x-ray treatment was concerned in the remaining four years (1939–42) of the study. We now use deep x-ray therapy first only in advanced or septic cases. In favorable cases, x-rays are used two months after radium. The gross incidence of complications has been reduced in the last four years of this series from 23 per cent to 7.5 per cent. In the total of 114 cases treated by *x-ray before radium*, the complication incidence was 20 per cent. In the 120 cases treated by *x-ray after radium*, the complication incidence is 10.8 per cent. In the total of 113 cases in which *radium needles alone* were used the complication incidence is 12.4 per cent, about the same as for x-ray after radium.

Our experience with deep x-ray and radium in regard to the *interval between treatments* is shown in Table IV. In 94 cases in which x-ray therapy was given less than one month before or after radium, the incidence of complications was 22.3 per cent, compared with a gross incidence, for all stages, of 12.3 per cent when radium was used alone. By increasing the interval to more than four weeks and less than nine weeks, we halved our gross complications, and where x-ray was postponed to the third month, the incidence fell to an even lower figure, 8.8 per cent. By increasing the interval to at least eight weeks, we have improved our results and have cut down our complications.

In order to reduce the x-ray overdosage to the paracervical area, Dr. Batchelder adopted the practice of placing a 4-cm. lead strip over the lower abdomen above the symphysis. From 1939 through 1943[2]

[2] Four-year follow-up for 1943.

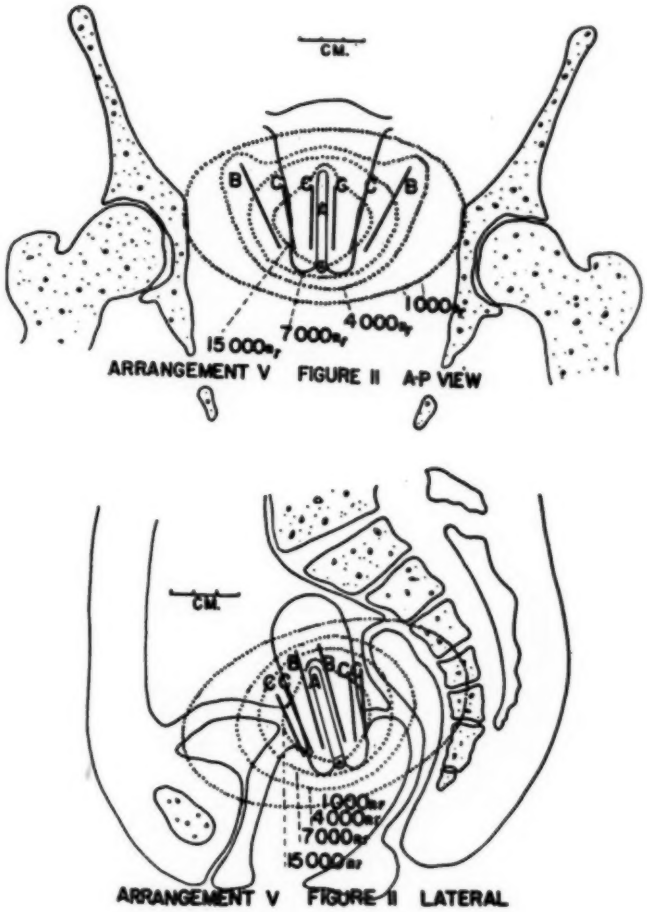


Fig. II. Arrangement V: Isodoses in Gamma Roentgens.

| Source | Number | Length (cm.) | Strength (mg.) | Time (hr.) | Mg. Hr. | Percentage of Total |
|---|---|---|---|---|---|---|
| A | 1 | 4 | 20 | 168 | 3,360 | Tandem |
| B | 4 | 4.5 | 12 (3 each) | 168 | 2,016 | 42 |
| C | 8 | 3 | 16 (2 each) | 168 | 2,688 | Needles |
| | 13 | | 48 | | 8,064 | 58 |

(Reproduced, with permission of the authors, from Nolan and Quimby; Radiology **40:** 397, 1943)

he has used this procedure in 72 cases, and in this series there have been only 4 severe complications, 5.6 per cent. This record is compared with a series of 184 cases treated without the lead strip in 1933–42, with 33 complications, or 12.5 per cent and thus seems to offer considerable advantage.

## COMMENT

With these results in mind, we are now ready to discuss our subject, "The Place of External X-Ray Irradiation in the Treatment of Carcinoma of the Cervix with Long Element Needles."

The better survival rate in Stage I and

II when x-rays were not used is quite striking, as is the lower incidence of complications. These facts confirm the clinical impression on follow-up, that with interstitial irradiation of this type the cervical, paracervical, and medial parametrial tissues receive a full cancericidal dose, so that further external irradiation would seem unnecessary and perhaps contraindicated. Quimby and Nolan, in 1943, calculated the isodose levels for an arrangement of interstitial needles and cervical capsules for an early, Stage I or II, case which we furnished them. The figure showing their calculations is reproduced here. Adequate dosage was supplied except in the lateral parametrium. It would seem reasonable to hold, therefore, that external x-ray irradiation is not needed over the central portion of the pelvis, as the dose from the needles and capsule in the immediate vicinity of the cervix, 15,000 r, is close to the limit of tolerance of normal tissues, beyond which breakdown occurs. In the more advanced Stage III and IV cases, the bulk of tumor is larger, extending farther toward the pelvic wall. According to our plan, more needles will be used in such cases and will be placed correspondingly farther out toward the pelvic walls, and isodose levels should show a much higher dosage there.

Tod, in 1941, reporting three-year survival rates for cases treated by intracavitary sources, also brought out the fact that in the early stage better results were obtained where *radium alone* was used. In 1946, a 5-year study of the same group, showed similar results. In the later stages Tod noted an improvement—about 7 per cent—corresponding closely to our own results, where x-ray *irradiation* was added. Her explanation of the better result in early cases with *radium alone* is that the paracervical tissues get about the limit of their tolerance dose from the radium sources and that, when deep x-ray irradiation is added in the early case with the smaller lesion, in an effort to destroy cancer in lymph node areas, enough added radiation is given to the paracervical tissues to cause serious and irreversible damage. This results in failure of the normal tissues to recover, increased complications, and a lowered five-year survival rate.

In the further advanced and more bulky tumors, the use of external x-ray irradiation does seem to add something, probably because the bulk protects the normal tissues to some degree.

If others corroborate these findings, and, in any event, with this experience behind us, we must treat the early case carefully. It would be too bad to increase complications and lower actual five-year survivals by over-treating in an effort to destroy problematic cancer in the lymph nodes.

That this matter of injury to normal structures in early cases is a serious one is shown in the experience of Meigs. In a discussion of Aldridge's paper on intestinal injuries following irradiation for carcinoma of the cervix, Meigs states that over 50 per cent of his severe intestinal complications fell in the *early stage groups*. This finding played, as he himself states, a large part in his abandonment of radiation therapy for surgery in these early cases. We might suggest from our own study that Meigs had been using too much radiation for the size of these early lesions.

A brief discussion of a paper published by Taylor and Twombly in October 1946 seems in order, since they report very poor results from an experiment with interstitial sources in the treatment of cancer of the cervix and have given the impression that their method was similar to that used by the present authors. If this were true, it would certainly cast serious doubt on our work. However, we differ in many important particulars!

Our method of radium treatment is one based on principles arrived at by close observation in long years of follow-up:

(1) Weak element sources consisting of 2- and 3-mg. needles (24–30 mg. total in early, and rarely more than 50 mg. in late cases), and a 20-mg. cervico-uterine applicator. These element sources give out a constant radiation throughout the treatment period

(2) Gamma radiation—0.5 mm. Pt filter

(3) A long-time interval, 168 hours or seven days

(4) External x-ray irradiation *after radium* interstitially, with interval of eight weeks and protection of paracervical area by a lead shield

(5) Individualization of treatment, *i.e.*, variation of number and distribution of needles according to size and method of extension of lesion.

Taylor and Twombly used:

(1) Strong *radon* sources—60 to 212 mc. (average 100 mc.) in 12 needles, with 100 mc. in a central cervico-uterine applicator

(2) Filtration of 0.3 mm. Au

(3) Relatively *short time* interval (average 30 hours) versus our 168-hour long time interval

(4) External x-ray irradiation in full dose—6 portals, 12,000 r, completed only two weeks before interstitial radon treatment, with no provision for protection of paracervical tissues against over-radiation

(5) A standard pattern for all sizes of lesions, with no individualization.

We cite Taylor and Twombly's work because their experience was unfavorable and illustrates errors in principle in the use of interstitial radiation of cancer of the cervix uteri which we would correct in this paper. On comparison of the two methods which we have presented, it becomes obvious that there are major differences and principles involved. Taylor and Twombly used what amounts to *massive* doses interstitially. They treated large and small lesions alike and used too much radiation externally too soon before interstitial *radon* treatment. They did this in a series of 94 cases—64 of which were Stages I and II—presumably *early cases*.

## SUMMARY

The authors have reviewed the last ten years of their experience in the treatment of carcinoma of the cervix for which five-year results can be reported. Tables are shown comparing results in five-year survival rates and gross complication rates, in cases treated with radium alone and with radium plus external x-ray irradiation. Comparison is made between results in cases when x-ray is given *before* and *after* radium treatment, and a table is presented to illustrate the effect of interval on complication rates. The use of a lead shield over the lower abdomen is described and the improved results following its use are shown.

## CONCLUSIONS

In making use of long paracervical and parametrial element needles, great caution should be used in Stage I and II cases in the employment of x-ray radiation externally. The cervix and paracervical triangle should be shielded as much as possible or the x-ray beam should be directed away from these areas.

The use of x-rays *after treatment with radium* at an interval of nine to twelve weeks has given the best results in freedom from complications. In the badly infected and more advanced cases preliminary x-ray therapy has its proper place.

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(*For Spanish Summary, see following page*)

SUMARIO

**El Papel de la Irradiación Roentgen Externa Profunda en el Tratamiento del Cáncer del Cuello Uterino con Agujas Largas de Radio-Elemento**

En el período 1933–42, 347 casos de cáncer cervical fueron tratados con radio solo (agujas largas intersticiales con elemento) o con radio e irradiación externa con rayos X. Dividiendo los casos en operables (Períodos I y II de Schmitz) e inoperables (Períodos III y IV de Schmitz), el A. observó que en el grupo operable la adición de la roentgenoterapia rebajaba el coeficiente de sobrevivencias de cinco años y acrecentaba la incidencia de complicaciones. En cambio, en el grupo inoperable, el coeficiente de sobrevivencias de cinco años subía y la incidencia de complicaciones disminuía al usar los rayos X. También se descubrió que la incidencia de complicaciones bajaba al administrar la irradiación roentgen después más bien que antes de la curieterapia y al alargar a dos meses el intervalo entre los dos tratamientos. El empleo de una pantalla de plomo sobre la porción inferior del abdomen durante la irradiación roentgen resultó ser un auxiliar más en la prevención de complicaciones.

Las conclusiones son éstas: Al utilizar agujas largas paracervicales y paramétricas de radio-elemento, hay que mostrar cautela al emplear la roentgenoterapia externa en los casos de los Períodos I y II. Hay que resguardar el cuello y el triángulo paracervical lo mejor posible o que asestar el haz de rayos X fuera de dichas zonas. El uso de los rayos X a un plazo de nueve a doce semanas después del tratamiento con radio ha resultado ser lo mejor con respecto a falta de complicaciones. En los casos muy infectados y más avanzados la roentgenoterapia preliminar tiene su lugar propio.

# Carcinoma of the Cervical Stump[1]

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CARCINOMA OF THE cervical stump has received considerable attention in gynecological literature for many years. A large number of articles have been written regarding the subject. In 1921 Polak (1) was able to collect only 256 cases from the American literature. Since that time, many cases have been reported.

Meland), 1,906 cases of carcinoma of the cervix were seen from 1922 to 1947. During the same interval, 165 cases of carcinoma of the cervical stump were referred to us for examination and radiation treatment. All had been operated upon elsewhere by various kinds of surgeons, experienced and inexperienced. The incidence of

TABLE I

PERIOD BETWEEN HYSTERECTOMY AND DIAGNOSIS OF CARCINOMA OF CERVICAL STUMP 1922-1947

| | NUMBER OF CASES | % |
|---|---|---|
| TOTAL | 165 | |
| A OCCURRING BEFORE 2 YRS. | 63 | 38.2 |
| B " AFTER " " | 102 | 61.8 |

GROUP B PROBABLY REPRESENTS THE TRUE OR ACTUAL CASES OF CARCINOMA OF CERVICAL STUMP. IN GROUP A THE DISEASE PROBABLY EXISTED AT TIME OF SUB-TOTAL HYSTERECTOMY.

| | NUMBER OF CASES | INCIDENCE |
|---|---|---|
| CARCINOMA OF CERVIX | 1906 | |
| CARCINOMA OF CERVICAL STUMP | 165 | 8.0% |
| PROBABLY TRUE CARCINOMA OF CERVICAL STUMP | 102 | 4.9% |

The incidence of cancer of the cervical stump is difficult to determine, as is the incidence of cancer of the cervix. It has been reported in the literature to be from a fraction of 1 per cent to 8 per cent (Black, 2). The general consensus of opinion is that it is probably from 1 to 2 per cent. Fricke (3) has pointed out that the figure may be higher in radiological institutes where large numbers of cases of cervical cancer are seen.

In our institute (Soiland, Costolow, and

carcinoma of the stump is thus 8 per cent of our total series of 2,071 cases (Table I). In 63 of the 165 cases, cancer occurred in the first two years after supravaginal hysterectomy and probably should not be classified as true carcinoma of the cervical stump. If we consider only the remaining 102 cases as true or actual carcinoma of the cervical stump, our incidence is reduced to 4.9 per cent.

The question of the prevention of carcinoma of the cervical stump has interested

[1] From the Los Angeles Tumor Institute. Presented at the Thirty-third Annual Meeting of the Radiological Society of North America, Boston, Mass., Nov. 30–Dec. 5, 1947.

surgeons and gynecologists for many years and has led to many controversies regarding subtotal versus total hysterectomy for fibroids and benign conditions of the uterus. It is not the purpose of this paper to enter into this controversy, and, being a radiation therapist, I would not be eligible. However, to any observer of the literature it would seem that there are a number of established facts of importance regarding these procedures.

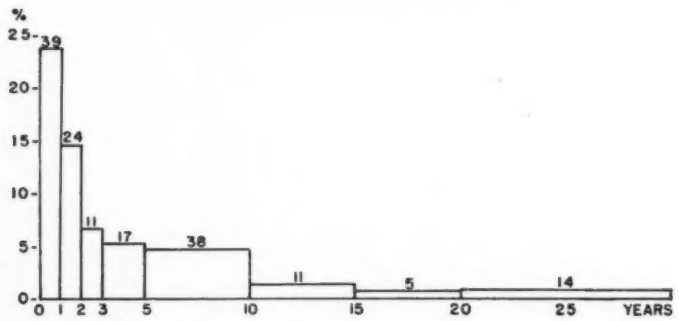
try in all patients, to prevent the occurrence of cancer of the cervical stump, would be the cause of far more deaths in an attempt to prevent cancer than would cancer itself."

Dr. Meigs, in a recent personal communication, informs me that his present views regarding total hysterectomy are those expressed in his article in the *New England Journal of Medicine* in 1944 (7). To quote from his recent letter: "A total hysterectomy

TABLE II

PERIOD BETWEEN HYSTERECTOMY AND DIAGNOSIS OF CARCINOMA OF CERVICAL STUMP

165 CASES SEEN 1922-1947




6 CASES (3.6%) PERIOD UNKNOWN

Apparently the mortality in large centers with skilled operators is about the same for subtotal and total hysterectomy, the morbidity being slightly higher for the latter procedure. Undoubtedly, in the hands of the occasional operator and average general surgeon the mortality is higher with total hysterectomy. Meigs (4) compares the mortality figures for total and supravaginal hysterectomies in the Massachusetts General Hospital as follows: 224 total hysterectomies—mortality 4.4 per cent; 1,771 supravaginal hysterectomies—mortality 2.9 per cent, a difference of 1.5 per cent, or more than twice the incidence of cervical stump carcinoma in the same hospital.

Meigs' summary of the situation seems very pointed: "To advocate total hysterectomy to all surgeons throughout the country is really the only satisfactory operation, and for the past five years in our clinics at the Massachusetts General Hospital, we have rarely ever had the house staff, the resident staff, or the visiting staff do a supravaginal hysterectomy.... Total hysterectomy is the only way to do an operation when the uterus is to be removed. A supravaginal hysterectomy should be almost completely discarded."

Some authors have felt that supravaginal hysterectomy plus cauterization or conization of the cervix was adequate as a prevention of the later development of carcinoma of the stump. Von Graff (5) points out that cancer can still originate after such a procedure from the squamous-cell epithelium of the vaginal surface of the cervix. This occurred in several of our cases. Of course, carcinoma at times

develops in the vaginal vault after total hysterectomy, and, as Ward (6) has stated, in the cicatrix in the vaginal vault.

A study of the time interval between supravaginal hysterectomy and the onset of carcinoma in the cervical stump is of interest (Table II). In our series, the average interval between subtotal hysterectomy and the development of cancer was six years. If carcinoma occurs in the stump within the first year following supravaginal hysterectomy, it is considered as having been present at the time of operation. Some observers believe that this time interval should be extended to two or even three years. It would certainly seem that a two-year interval should give a fair picture. In Table I it is seen that 38.2 per cent of our cases occurred in the two-year interval. Probably in most of these patients cancer was present at the time of supravaginal hysterectomy. This appalling figure shows the inadequacy of cervical examinations and the lack of careful study of cases before operation. A great many patients had been operated upon without previous dilatation and curettage or biopsy of the cervix. In dividing these cases into intervals of years, it was necessary in most instances to take the date of appearance of bleeding as the possible time of the onset of disease. However, it was evident in many cases that it had been present some time before, as shown by the advanced stage.

### TECHNIC OF TREATMENT

Radium and x-rays were used in combination in the treatment of practically all cases. If possible, radium was inserted into the cervical canal. In many of the cases, radium was packed against the cervical stump and vault. Often a flat type of vaginal applicator was used, containing from 50 to 75 mg. of radium element with a filtration equivalent to 2 mm. of platinum. The applications were fractionated, the radium being reinserted after twenty-four hours. Two seances, two weeks apart, were generally given. The application was made in the knee-chest position so that the bladder and rectum could be protected by thorough packing. The total dosage varied from 4,000 to 5,000 mg. hr., or 2,880 to 3,600 gamma roentgens.

In addition, roentgen therapy was used, often immediately following the radium cycle. We believe adequate roentgen therapy to be extremely important in these cases. From 1922 to 1934 we used 180- to 200-kv. roentgen therapy. Since then supervoltages—450 kv. to 500 kv.—have been employed. The present factors are 450 kv., target-skin distance 50 cm., filter equivalent of 1 mm. lead, 15 r per min., wavelength 0.06 Å., half-value layer 5 mm. copper. The amount of therapy has varied from a tissue dose of 3,000 to 5,000 r to the mid pelvis. The treatment is fractionated over a period of five to six weeks. The number and size of the portals vary according to the pelvic measurements of the patient.

The average dosage in the cervical stump cases is less than that for primary carcinoma of the cervix. Usually the stump cases present more difficulty and complications following radiation therapy due to reaction in the bladder and rectum.

### RESULTS

Table III, demonstrating the results of our series of cases, is self-explanatory. In the earlier cases an attempt was made to use the Schmitz classification; later the international classification was employed. In some cases, however, it was difficult to determine accurately the extent of the disease. Consequently, we do not feel that an attempt to show the relation between the extent of involvement and the five-year survival rate in this series would afford information of much value. Certainly, carcinomas of the cervical stump are not seen in the early or Stage I group any more frequently than is carcinoma of the cervix.

It will be seen that the grade of the tumor has not been considered in tabulating our results. Tumors were not usually graded according to the degree of malignancy in our community during the first ten-year period in which this series of

cases was treated. The pathological report showed either squamous-cell carcinoma or adenocarcinoma. The great majority were squamous-cell carcinomas. However, all cases treated had a microscopic diagnosis of carcinoma. During the past fifteen years, practically all cases have been graded according to the degree of malignancy.

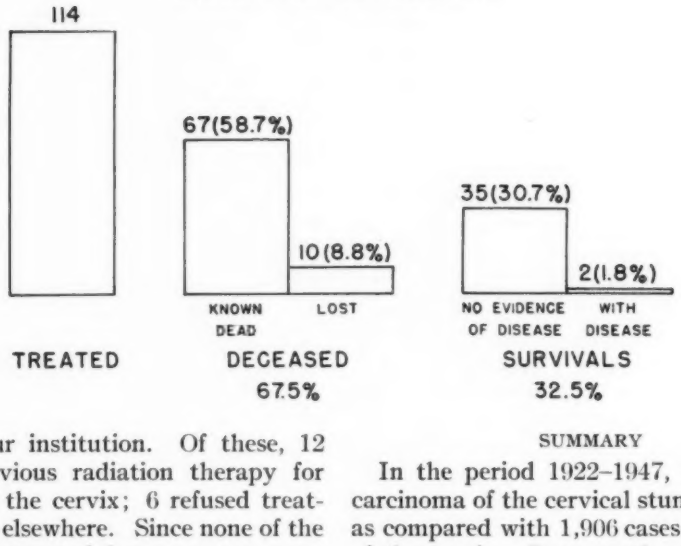
Of the 165 cases, 18 are eliminated from consideration, since the patients were not treated in our institution. Of these, 12 had had previous radiation therapy for carcinoma of the cervix; 6 refused treatment or went elsewhere. Since none of the 18 cases was treated by us, we are unable to make any analysis of the results.

The follow-up in the remaining cases was 91 per cent. Ten patients were lost and are classified as dead. As shown in Table III, the percentages were: 67.5 deceased and lost; 32.5 five-year survivals; 1.8 alive after five years with disease, and 30.5 alive without evidence of disease. It is interesting to note that of the 35 patients who survived five years or longer without disease, 11 lived more than ten years and 6, or 5.3 per cent of the 114 treated, survived twenty to twenty-five years (Table IV).

TABLE IV
CARCINOMA OF CERVICAL STUMP
5 YEAR CURES
(SURVIVAL WITHOUT DISEASE)
114 CASES TREATED

| SURVIVAL PERIOD TO DATE | NUMBER OF CASES | % |
|---|---|---|
| 5-10 YEARS | 24 | 21.0 |
| 10-15 " | 4 | 3.5 |
| 15-20 " | 1 | 0.9 |
| 20-25 " | 6 | 5.3 |
| 5-25 " TOTAL | 35 | 30.7 |

TABLE III
CARCINOMA OF CERVICAL STUMP
5 YEAR SURVIVAL RATE
CASES TREATED 1922-1942




## SUMMARY

In the period 1922–1947, 165 cases of carcinoma of the cervical stump were seen, as compared with 1,906 cases of carcinoma of the cervix. In more than one-third of 165 cases of carcinoma of the cervical stump, the disease occurred within two years after supravaginal hysterectomy. These cases should be considered as probably existent at the time of operation. The remaining 102 cases were probably actual or true carcinoma of the stump, giving an incidence of 4.9 per cent based on the total number of cervical cancers for the twenty-five year period.

The necessity of thorough examination of the cervix and uterine canal before supravaginal hysterectomy is indicated.

Adequate radiation treatment is essen-

tial in order to secure favorable results in carcinoma of the cervical stump, but careful technic is necessary to avoid rectovaginal and vesicovaginal fistulas.

A five-year survival, without disease, of 30.7 per cent was obtained in the cases treated.

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SUMARIO

## Carcinoma del Muñón Cervical

En el período 1922–1947, 165 casos de carcinoma del muñón cervical fueron observados en la clínica de los AA., comparado con 1,906 casos de carcinoma del cuello uterino. En más de la tercera parte de los casos de carcinoma del muñón, la enfermedad apareció en término de dos años de una histerectomía supravaginal. Estos casos deben considerarse como probablemente existentes al ejectutarse la operación primitiva. Los otros 102 casos eran probablemente real o verdadero carcinoma del muñón, representando 4.9 por ciento de la serie global de carcinomas cervicales durante los 25 años abarcados por esta comunicación.

La necesidad de un minucioso examen del cuello y el conducto uterinos antes de proceder a una histerectomía supravaginal es recalcada por el elevado porcentaje de cánceres presuntamente residuales.

La radioterapia adecuada es indispensable para obtener resultados favorables en el cáncer del muñón cervical, pero se necesita una técnica esmerada para evitar la formación de fístulas rectovaginales y rectovesicales. Los AA. utilizan una combinación de curie- y roentgenoterapia. La dosis de radio administrada en dos sesiones es de 4,000 a 5,000 mg.-horas. La roentgenoterapia es fraccionada durante un período de cinco a seis semanas. La dosis histológica ha variado de 3,000 a 5,000 r en la mesopelvis. El coeficiente de sobrevivencias de cinco años para los 114 casos tratados representó 30.7 por ciento.

# Probable Trends in the Irradiation Treatment of Carcinoma of the Cervix Uteri with the Improved Expanding Type of Radium Applicator[1]

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*An improved expanding type of radium applicator is presented to meet the problem of obtaining a greater degree of radiation effectiveness in the potentially metastatic parametrial pelvic fields, in the treatment of carcinoma of the cervix uteri. Just as the adoption of the multiple-port method was a prerequisite to advances in roentgen therapy, so, if a more effective and uniform method of irradiation is to be achieved in the treatment of moderately advanced lesions beyond the cervical os, the number of cross-fire radium sources must be increased. It is likewise essential that the uniform spacing of these multiple equal sources of radium be not disturbed when the lateral capsules of the particular type of radium holder adopted are expanded to pre-established fixed positions, irrespective of the anatomical size and shape of the vaginal vault or the extent of the malignant infiltration.*

*Investigations of the related clinical and physical radiation therapy requirements recently completed at The Barnard Free Skin and Cancer Hospital and DePaul Hospital (St. Louis) have shown that our former routine methods of applying radium in carcinoma of the cervix were not in complete conformity with the accepted principles and sound practices of radiation physics. Evidence was found, unfortunately, of many questionable technical procedures and numerous dosage inconsistencies. We therefore sought a more effective technic of applying radium, beginning with a comprehensive analysis and comparative clinical study of the infiltrating tendencies of moderately advanced malignant cervical lesions in relation to the radiation distribution factors and the gamma-roentgen measurements obtained with the various methods of radium application.*

## HISTORICAL

FOR MANY YEARS WE experimented with a double cross-arm radium applicator in combination with semi-fixed lateral colpostats for the treatment of carcinoma of the cervix. In 1944, by means of six serial photographic film exposures, we evaluated the interrelated intensity distribution factors of this type of radium applicator, employing a wax phantom for registering the back-scattering effects of the various radium sources (1).

By superimposing these six films (Fig. 1), which had been exposed to the radium capsules of the applicator behind a strong light, the combined distribution and radiation effects could be visualized and photographically reproduced in relation to the average cancer spread within the human pelvis. The need for additional auxiliary colpostats was self-evident, and separate individual London type capsules or spring colpostats were used. It was found difficult at times, however, to pack these auxiliary colpostats in their proper position near the parametrium, and even when they were properly placed in the vaginal fornices, there was little assurance that they would remain fixed there.

Again reviewing our private and clinic results the following year, we recognized that our former minimal technical routine requirements were inadequate if we hoped to increase further the effectiveness and safety of future therapy procedures when larger radium doses were to be employed.

We had in mind a single radium unit

[1] Presented at the Thirty-third Annual Meeting of the Radiological Society of North America, Boston, Mass., Nov. 30–Dec. 5, 1947.

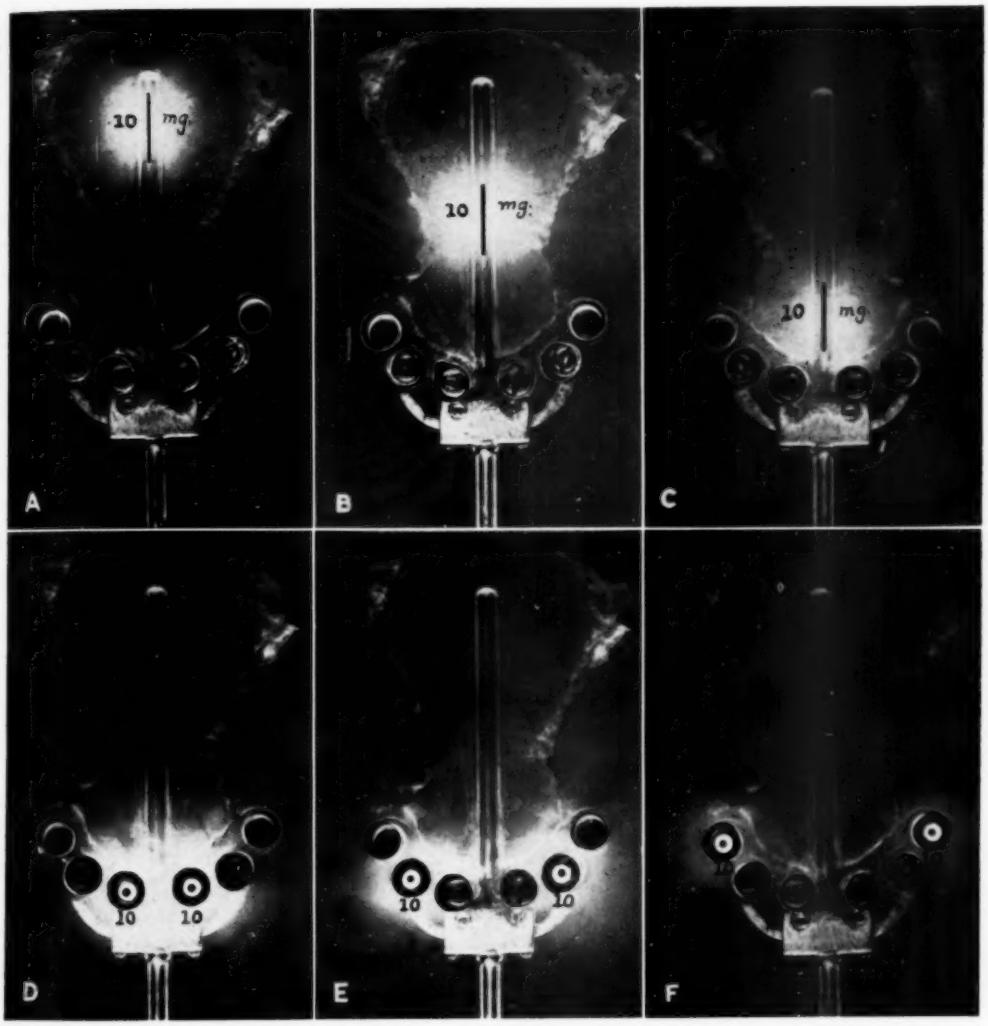


Fig. 1. A. The white "halo-like" photographic effect shown in the region of the fundus of the uterus indicates the extent of the radiation distribution, with back-scattering, from a 10 mg. radium needle (filtration, 0.5 mm. platinum and 2.0 mm. brass).

B. A similar effect is noted when 10 mg. radium is placed in the mid-cervical canal region of the uterus.

C. Radiation distribution effect noted in the lower cervical canal region near the os.

D, E, F. Note the individual circular radiation effect from the bilateral vertical cross-arm radium sources near the cervical os (D), the mid-lateral sources (E), and the extreme outer capsules (F) toward the parametrial areas of the vaginal vault.

In order to assure direct contact and accurate duplication of the separate exposures, six circular openings, the size and shape of the vertical capsules, were made in each film prior to exposure to the radiation. The exposure times were equal. These photographic film studies were most helpful in the planning and designing of our applicator, but are not to be considered as an ideal method of dosage measurement. Either the ionization method or the slow-film gamma-roentgen dosage method, described elsewhere, is a more accurate procedure.

type of applicator to replace the multiple separate radiation sources previously packed throughout the vaginal vault. It seemed essential that the individual units be combined in a composite applicator or holder that could be introduced easily, and also that the sources of radiation be fixed in a more strategic position around the parametrium and behind the primary cervical os lesion. Furthermore,

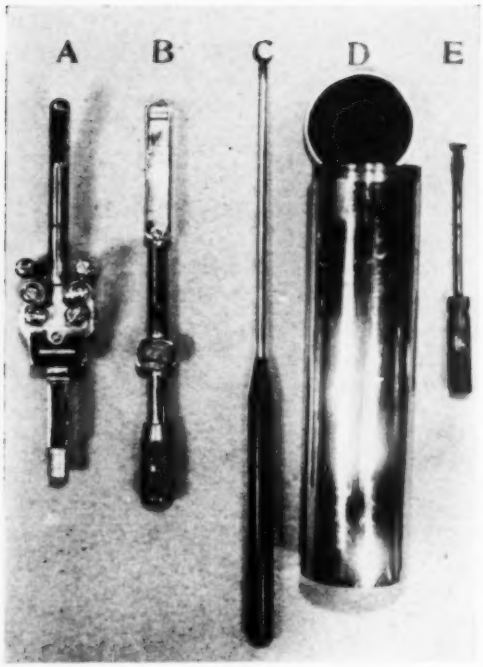


Fig. 2. A. The cervical uterine radium applicator in the closed position. The transverse diameter of the applicator when the colpostats are contracted measures less than 3.0 cm.; this makes for ease of introduction.
B. The outer end or rotating knob of this handle can be attached to the radium applicator, which directly controls the expansion of the lateral colpostats. The lateral capsules, except the two inner ones, are automatically spaced 1 cm. apart in the vaginal vault when the rotating knob is turned to the extreme left. After the introduction, the handle is detached and the applicator is packed and fixed in the desired expanded position.
C. For removal of the radium, this metal rod is screwed into the outer end of the applicator. This contracts the lateral colpostats to facilitate removal of the applicator.
D. Screw-top metal container for transportation and sterilization of implements shown in A, B, and C.
E. Special type of blunt-pointed screw driver facilitating removal of the screw tops of the capsules with a minimum amount of exposure to the operator.

we felt it vitally important that the relative positions of these radiation sources be reasonably fool-proof, so that duplication in every case could be achieved with consistent uniformity.

Such a composite unit applicator must be mechanically simple, clinically practical, easy to apply, and relatively flexible for meeting the many different anatomical and pathological forms of cancer of the cervix and its parametrial extensions.

At the Second Mexican Cancer Congress at Guadalajara in February 1946, at the Second Inter-American Congress of Radiology in Havana in November 1946, at the meeting of the Radiological Society of North America in Chicago in December 1946 (2), and again at the Fourth International Cancer Research Congress held in St. Louis in September 1947 (3), we exhibited a series of expanding colpostats and cervical applicators of different types for meeting most of what we had determined were the essential pelvic irradiation requirements.

We have since further improved the mechanical features of this cervical applicator and expanding colpostat, based on actual clinical experience in 49 cancer cases (4), but the fundamental physical principles of uniform fool-proof spacing of multiple equal sources of radium were never violated.

Unless the seven or nine individual radium sources remain accurately spaced, the maximum effectiveness and advantages of uniform distribution throughout the pelvic vault cannot be realized. In the past, it has been difficult to place the individual colpostats in the correct position along the lateral walls of the fornices, and it has been equally difficult to fix these lateral-wall colpostats in their proper safe and effective position in relation to the primary lesion in the cervical os and the surrounding parametrial fields.

## CLINICAL OBSERVATIONS

It may be of interest to discuss our clinical impression of the initial and secondary reactions of the vaginal wall mucosa, and the changes following the use of the present method of radium application, as compared with the results obtained with our former hit-and-miss method of packing multiple individual radium capsules in various positions within the vaginal vault against the cervical os. When employing our former method of radium application and attempting to increase our dose in excess of 6,000 mg. hr., we frequently encountered "hot spots." When we em-

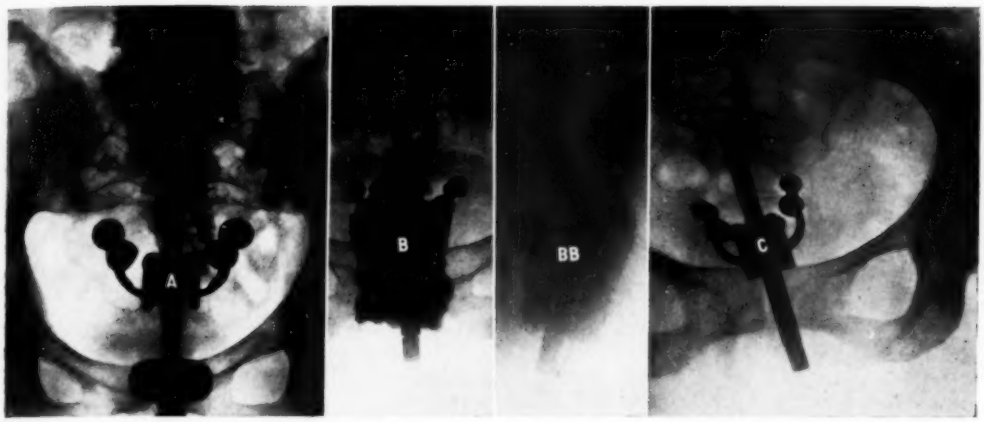


Fig. 3. A. Anteroposterior pelvic roentgenogram showing the radium applicator in the expanded position within the uterine cervical canal and vaginal vault. Following each application of radium, irrespective of the method employed, it is essential to check the position of the radium capsules roentgenographically.

B. The position of the applicator is shown in relation to the vaginal gauze pack when dipped in a solution of barium sulfate.

BB. Lateral view showing the radium applicator and the opaque barium sulfate vaginal gauze pack in relation to the rectum and bladder.

C. Slightly angulated position of the radium applicator to conform to an abnormally displaced cervical os. The cross-fire sources of the radiation beams, however, remain unaltered in relation to the potentially cancerous cervical and parametrial fields. (The author acknowledges his indebtedness to H. Muench, R. Ernst, B. Schutt, and Dr. Nolan for their helpful suggestions.)

pirically increased this single application dose to 7,200 mg. hr., more definite localized areas of necrosis or slow-healing sinuses developed in the majority of our cancer patients, due to the unequal distribution of radiation. Our only safe alternative was to reduce the total radium dose, but this we did at the expense, perhaps, of satisfactorily irradiating the primary lesion but ineffectively treating the more important lateral parametrial fields. These unsatisfactory results with irregularly distributed concentrated radium sources were experienced prior to 1944.

With the introduction of the present type of expanding applicator (Fig. 2), however, the initial clinical reactions and vaginal wall changes appeared more homogeneous. This, of course, was due in a large measure to improved distribution of the radiation by correction of the alignment and spacing of the equal sources of radium intensity. In fact, except in a few experimental cases in which we attempted to increase the total dose far above the average routine application, we seldom observed localized necrotic areas due to over-irradiation or serious damage to the rectal or bladder fields.

We are reasonably confident that eventually this more uniform method of radiation distribution may advantageously, and with added safety, permit the employment of still higher radium intensity applications, if the fractional instead of the single-dose technic is employed. In view of the simplicity and practicability of this method of applying radium, and the saving in time effected by its use, the divided-dose technic should become more popular. The initial local tumor response and the comparative clinical follow-up changes in 49 consecutive patients have been most encouraging.

## SAFETY FACTORS

Since the upper and lower ends of the vertical capsules are in close proximity to the bladder and rectum, these end sources of limited radiations have been further protected by added distance and by 2 mm. of lead, thereby minimizing the possible radiation damage to nearby normal structures (Figs. 2 and 3).

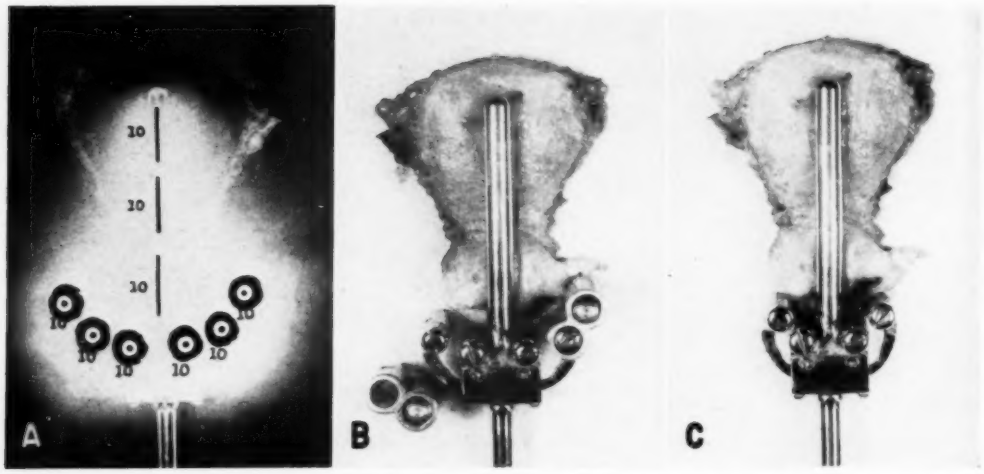


Fig. 4. A. In order to show graphically the combined radiation effect of the nine sources of radiation of the applicator, the six exposed films (Fig. 1) were superimposed upon one another. With the aid of a strong light, the combined distribution of the radiation throughout the cervical canal and pelvis is shown in a single photograph.

B. When the contracted vaginal vault measures less than 6.5 cm., one or both of the lateral colpostats can be removed. However, the advantages of six instead of four vertical capsules are demonstrated in the photograph, showing a more effective lateral irradiation toward the parametrium. The reverse is true in photograph C.

C. This pathologic specimen demonstrates the need for an additional lateral colpostat to irradiate more directly the parametrial extension of the primary cervical os lesion. Note beginning lateral cancer extension.

With each application of radium for the treatment of cancer of the cervix, roentgenograms of the lower pelvis in both the anteroposterior and lateral positions should be made immediately after introduction of the radiation sources (Fig. 3). Abnormal rotation of the applicator can be easily corrected at this time after removal of the gauze pack. In all our cases, the position of the radium holder was checked within the pelvis by means of roentgenographic studies, and in no instance, even in ambulatory patients, was there any evidence of appreciable shifting of the radium capsules.

It might be of interest to note that the actual time required to place the applicator in the proper position within the dilated cervical canal and parametrial region is less than ten seconds. The subsequent packing of the radium holder requires a much longer period.

*It is dangerous, however, to assume that any specific method of applying radium within the vaginal vault is absolutely safe.* When average care is exercised in the use of the applicator here described, the expanding feature assures accurate 1-cm. spacing of all the sources of radium (Fig. 4, A). The danger of dislodgment of colpostats toward the rectum or bladder is minimized. Unilateral individualization of the therapy procedure by adding or removing one or two lateral capsules (Fig. 4, B and C) is helpful in the management of an abnormally contracted vaginal vault or atypically distributed cancer infiltration. Far-advanced cases, even when the cervical canal is absent, can be palliatively irradiated by unscrewing and detaching the cervical stem portions of the applicator.

## RADIATION DISTRIBUTION

We have evaluated both the single capsule and the total radium intensity pelvic effects of the applicator upon photographic films by substituting a presdwood phantom for the soft tissues of the pelvis, in order to assure ourselves that all the surrounding pelvic fields were uniformly and effectively irradiated, as shown in Figures 1 and 4, A. Since our early exhibits and scientific presentations (2), somewhat similar applicators have been

described by other observers (7). Unfortunately, however, the fundamental physical principle of uniform distribution of equal sources of radium has been neglected in these attempts at duplication of our early 1946 model (2).

A slow-film method of dosimetry by Nolan and Natoli (5) and Nolan and Quimby (6) was utilized for the study of the radiation distribution of this applicator when presdwood was employed as a phantom (Fig. 5). The photographic slow-paper film studies were designed to measure the intensity in gamma-roentgens per milligram hour exposure with the radium applicator as used *in vivo*, and these measurements were made with back-scattering of the combined group of radium sources. This analysis took into account that in each of our special measurement studies we employed 10 mg. radium (filtration, 0.5 mm. platinum) in individual brass capsules (filtration, 2 mm. brass), with a total filtration of 1 mm. platinum equivalent. The radiation with the expanded applicator, to the midline at the level of the internal os, when compared with the Manchester method and graph, presented more or less similar ideal equal distribution factors, but without the more complicated and uncertain technical requirements of the former method. The isodoses in gamma roentgens per milligram hour exposure for the various radium sources are shown in Figures 6–9, and their interpretation by Dr. Nolan, who made the measurements, are as follows:

"A film method of dosimetry which has been described previously (5) was utilized to study the radiation distribution around the special applicator designed by Dr. Ernst. The experimental studies were carried out in a presdwood phantom. They were so designed that the radiation in roentgens per mg. hr. exposure of the applicator, as used *in vivo*, could be measured. This method took into account the special filtration and placement of each source as described by Dr. Ernst. Certain variations were studied, however, which are described as changes in the radiation pattern with variation in the percentage dose of the individual sources. In other words, the total amount of energy delivered by the entire applicator was kept constant, but the percentage of this energy contributed by each source was varied.

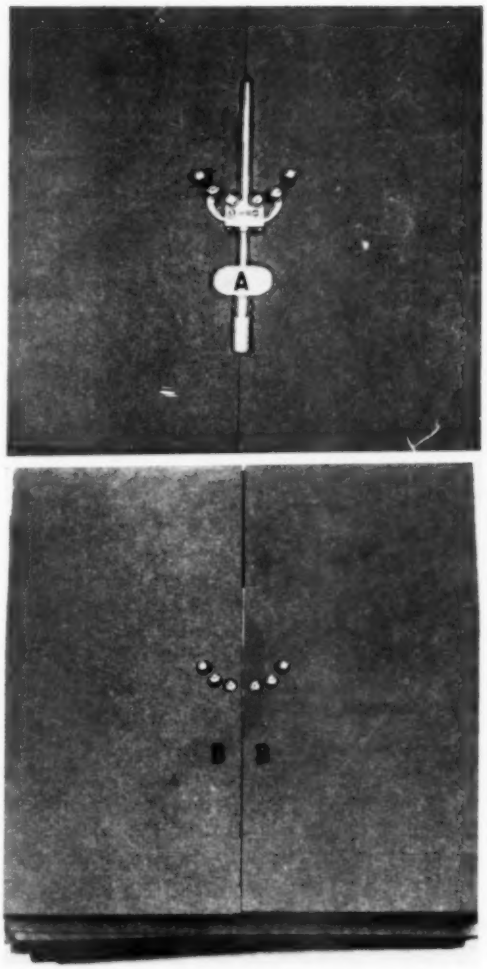


Fig. 5. A. Presdwood sheets were employed for both the fast x-ray film studies and the slow-paper film studies of the radiation distribution and dosage measurements. The half sheets made it possible to place the films in the vertical or upright position, as well as horizontally.

B. Various depth-dose distribution studies were made possible because of the quarter-inch presdwood individual sheets. These sheets surrounding the vertical capsules could be built up to any height and gave us valuable distant irradiation effects and percentage depth dose factors.

"In the first series of experiments, at-

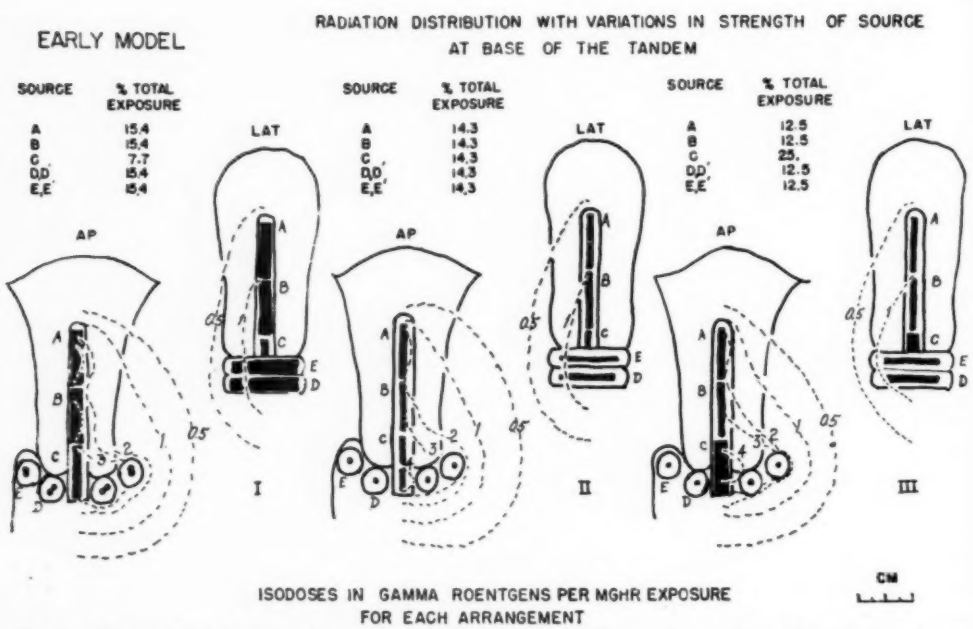


Fig. 6. Isodoses in gamma roentgens per mg. hr. exposure for three early experimental arrangements. In Arrangement I the distal intracervical capsule C contains one-half as much radium as the remaining two cervical and four vaginal fields. It can be observed that the over-all distribution effect is fairly uniform. With Arrangement II, in which all seven capsules of the applicator contain equal amounts of radium, there is beginning evidence of over-irradiation effects in the cervical os region. This is due in part to unequal spacing or low position of the distal intracervical capsule C. Correction of this will be discussed in connection with later experiments. In Arrangement III, with double the amount of radium in the distal cervical applicator (C), the cervical os field shows marked evidence of over-irradiation or "hot-spot" effects.

tention was directed to the possible effects around the external os of the cervix and variations in the dose from the source at the base of the intracervical tandem were studied. An early model of the applicator was used, which had the distal quarter of the basal source on a line with the centers of the medial vaginal sources. The diagrams in Figure 6 show the results of these comparative studies. One can see that the proximity of the intracervical and vaginal sources gives an area of over-irradiation near the external os in Arrangement II. When the basal source is called upon to deliver twice as much energy as the other sources, as in Arrangement III, the area of over-irradiation becomes more noticeable; when only half as much energy is delivered, as in Arrangement I, the area of over-irradiation disappears.

"From such studies it was concluded that it would be more effective to move the cervical stem up into the uterus than to vary the strength of the various sources, so a newer model was constructed. In this, the centers of the medial vaginal sources are on a line 0.5 cm. distal to the end of the source at the base of the tandem. Also, it was postulated that additional vaginal sources in the lateral position would improve the whole radiation pattern.

"Figure 7 shows the radiation pattern around this newer model, with the variations in the number of equal sources used. Arrangement V utilizes nine sources of equal strength and shows a tiny area of possible over-irradiation near the base of the tandem. Arrangement IV uses only four vaginal sources and is similar to Arrangement II, but gives a field of irradiation similar to Arrangement I. Arrangement VI uses six vaginal and only two cervical sources and shows possible over-irradiation throughout the distal cervix.

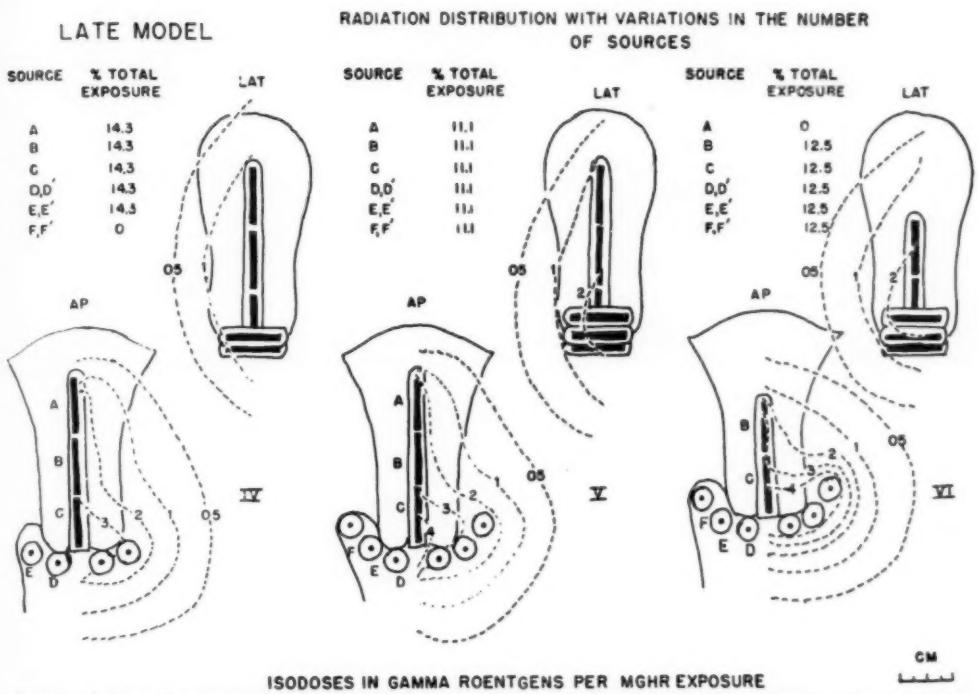


Fig. 7. Isodoses in gamma roentgens per mg. hr. exposure for three later experimental arrangements. In Arrangement IV the applicator shows only four vaginal sources and three cervical canal capsules. Equal sources of radium were employed throughout this new type of applicator. The cervical stem capsules A, B, and C, however, have been moved 1 cm. higher within the cervical canal in relation to the vaginal capsules. The isodose curves with this arrangement show increased uniformity of the radiation in the cervical os region. This change of spacing was made in preference to varying the strength of any individual capsule or group of capsules. Arrangement V utilizes nine sources of radiation of equal strength. The isodose curves indicate a uniform distribution of radiation throughout the body of the uterus and the parametrial regions with the exception of an extremely small field of possible over-irradiation near the base of the tandems. Arrangement VI employed six vaginal and only two intracervical sources and also shows a possible small area of over-irradiation near the distal cervix.

The present expanding applicator has been developed in conformity with Arrangement V, employing nine equally spaced radium sources.

"The effect of moving the tandem upward in the later model is shown by comparing the radiation distribution in Arrangements II and IV. Figure 8 shows graphically the resultant differences in the fields of these two plans at the level of the internal os of the uterus on the basis of possible biological effect from the amount of radiation alone. The radiation falling lateral to the midline at this level is shown for both plans at a calculated 5,000 mg. hr. exposure. The figures for Arrangement IV are slightly superior and the curves are quite similar.

"The variations in the number of sources used as seen in Figure 7 are practical considerations, as the available space in the uterus and upper vagina will dictate them. *However, Arrangement V (Fig. 7) is superior to the others and is the one which is most desirable.* A comparison between the radiation distribution from this arrangement and that calculated for the Manchester method is made in Figure 9. The graph is similar in construction to that of Figure 8, but the exposures are 8,000 mg. hrs. The Manchester figures are chosen because the values are higher than those for other methods of this type which have been calculated (6). The values calculated by Campbell (7) for an applicator somewhat similar in type to that of Ernst are lower than those for the Manchester method. The curves of Fig-

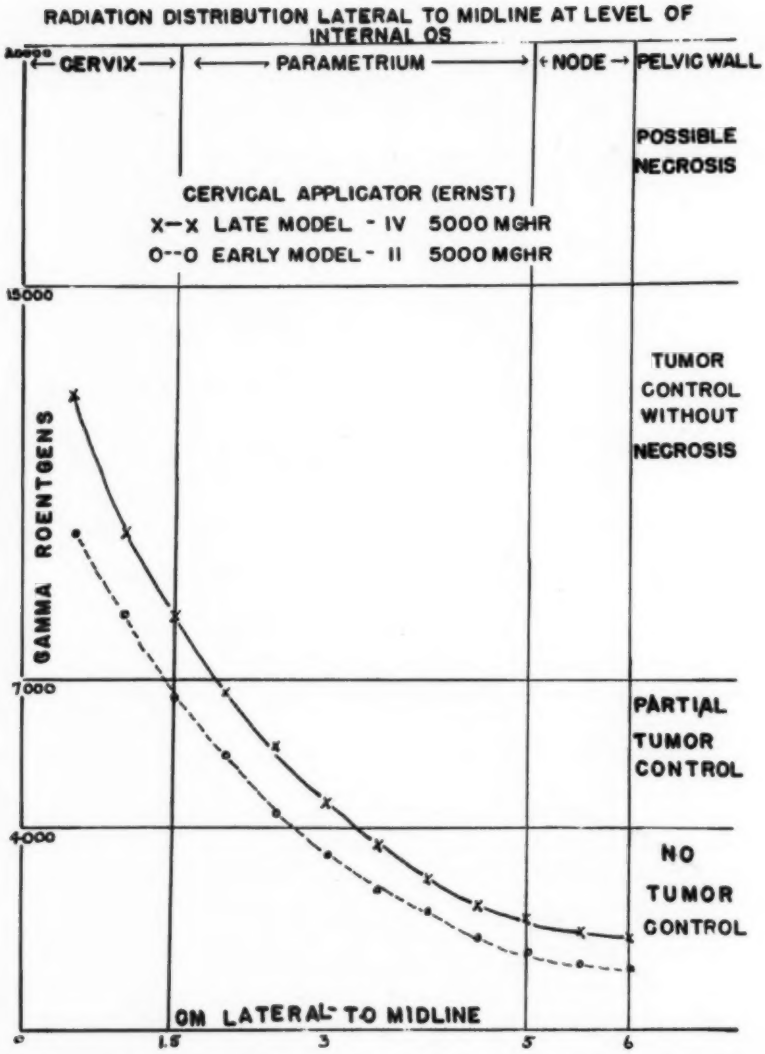


Fig. 8. The respective distributions of the radiation lateral to the mid-line at the level of the internal os with the early model II and the late model V are graphically compared in this chart. The curves are quite similar, but the distribution figures are slightly in favor of the late model V.

ure 9 show a slight superiority for this nine-source applicator when compared with the Manchester method. Because of possible necrosis in the cervix itself, it is probable that 8,000 mg. hrs. would be the upper limit of safety for a *single exposure.* (It has been observed clinically that with fractionation a much greater intensity can be administered in selected cases.)

"In summary, these studies show an improved field of radiation around the applicator in question. The improvement does not reach an absolute level of perfection, since the position of the sources is limited by the geography of the vagina and uterus. The adaptability of the applicator to irregular tumors may be limited by its rigidity. However, this rigidity

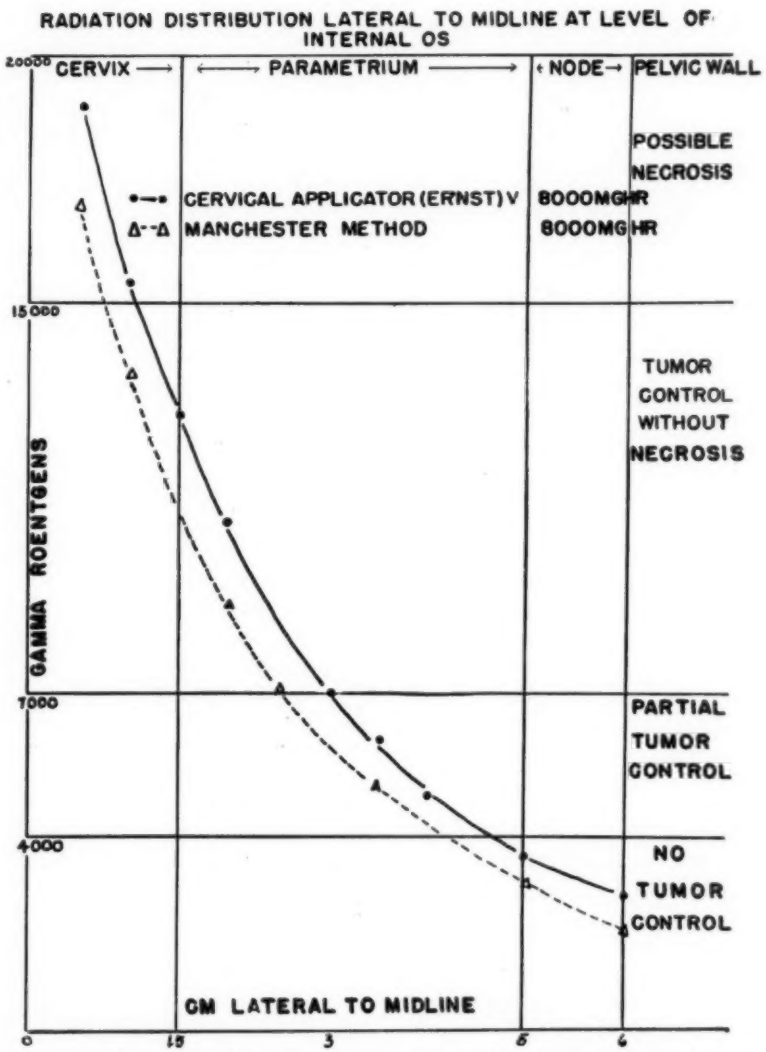


Fig. 9. This graph is similar in construction to the one shown in Fig. 8, but the mg. hr. exposures are calculated on the basis of 8,000 mg. hr. instead of 5,000 mg. hr. of radium. The Manchester figures have been selected for comparison because they are higher than the values with most other methods of this type which have been calculated. A comparison of the Manchester graph with the nine-source method of irradiation shows evidence of a slight superiority in favor of the late model applicator V.

yields a uniformity of the radiation fields which is desirable. Judicious use of the applicator should decrease dangerous reactions and still yield effective levels of radiation in patients with suitable lesions."

CLINICAL APPLICATION OF THE APPLICATOR

A. The depth of the cervical canal is initially determined by means of a suitable centimeter-marked uterine probe. The length of the cervical stem of the applicator is approximately 7 cm. when three longitudinal capsules are employed. Should the depth of the cervical canal measure less than 7 cm., it may be necessary to unscrew the distal stem; otherwise the vertical capsules will not fit snugly against the os, and the lateral colpostats will fail

to contact the parametrial fields effectively.

B. The second step to be taken before applying the radium is to measure the transverse diameter of the vaginal vault to determine whether four, five, or six vertical capsules can be safely expanded. The broader the lateral fields of irradiation, the more effective will be the therapeutic results (Fig. 4, A). When the lateral transverse diameter of the vault measures only 5 cm., four or five radium capsules can be comfortably introduced. The 6.5 cm. vault occasionally will accommodate six radium capsules.

C. If the cervical canal is occluded, in the so-called frozen pelvis type of advanced cervical cancer, the cervical stem of the applicator may be removed. In this group of widespread cancer infiltrations, the divided-dose method is especially helpful from a palliative standpoint, for the control of bleeding and infection.

D. While the roof and floor of the vaginal vault are being packed with a single narrow moist gauze strip, constant pressure upon the radium holder should be maintained. Occasionally an elastic bandage or binder under tension may be pressed against the fixed protruding handle, thereby increasing the contact pressure of the radium capsules with the fields under irradiation. The placing of several rolled towels beneath the binder over the protruding end of the colpostat is another practical method of flattening the cervical os and parametrial regions.

E. Should the vaginal wall be involved, the instrument may be tilted and then packed in a slightly angled position without jeopardizing the irradiation of the primary neoplasm within the cervical canal. Layers of sponge rubber interposed between the vertical radium capsules and the cervical os lesion and the vaginal wall extensions improve the depth dose.

F. Frequently in the contracted vaginal vault only four or five capsules can be accommodated. Even though it may be difficult to introduce the small Graves speculum in a relatively small vaginal vault, the applicator can be inserted without the use of retractors, provided the canal is patent and dilated. At the present time, we are experimenting with special types of plastic cones to facilitate the introduction of this cervical uterine applicator.

G. It should be remembered that the radium compartments of the applicator are designed for either one, two, or three 10-mg. needles. Radium tubes less than 4 mm. in diameter can be substituted for the needles. Routinely, we employ a 10-mg. radium needle in each capsule. This single needle is packed along the wall toward the operator away from the cervical lesion, thereby further increasing the depth dose factors. The combined capacity of the nine applicator compartments is 90 mg., 180 mg., or 270 mg., respectively, when the individual capsules contain equal amounts of 10, 20, or 30 mg. radium. Even 5 mg. radium needles may be inserted into each capsule, the total time of application being correspondingly increased.

H. The applicator may be dipped in a heavy bath of lubricant before its introduction. This facilitates subsequent removal of the discharge material which has a tendency to tarnish the instrument. It is essential to cleanse the apparatus immediately after use with soapsuds and a fine toothbrush or a small-bristle brush with a long handle. The apparatus, including the radium, may be sterilized by the usual boiling procedures.

I. After thorough cleansing, the instrument may be dipped in lysol solution and then placed in a brass tube (Fig. 2) containing a non-tarnishing antiseptic solution. This metallic tube holder should be surrounded by adequate lead protection. While in the operating room, the instrument remains in this metallic tube surrounded by a lead-lined collar until ready for use. This gives added protection to both operator and personnel. It should be made certain that the gauze packing has been removed. A single 3- to 6-yard narrow ribbon gauze pack

should be used. Multiple gauze packs are more difficult to remove. The gauze pack may be dipped in a barium sulfate solution for the added protection of the anterior vaginal vault, the bladder, and the rectum.

J. The cervical uterine colpostat is removed simply by screwing the end of the long wire rod clockwise into the small hole at the end of the exposed extending arm of the instrument. Automatically, as the rod is turned to the right, the lateral colpostats are retracted and the instrument is removed.

## SUMMARY

1. The technical advantage of this single-unit type of cervical uterine applicator for the treatment of carcinoma of the cervix is due to the mechanically controlled expansion features and to the accurate distribution of from seven to nine cross-fire radium sources within the pelvis.

2. The expanding feature of the lateral capsules and auxiliary colpostats of this instrument reasonably assures a much broader and more uniform distribution of radium intensities, thereby minimizing the danger of over-irradiation and the development of localized "hot spots" within the vaginal vault. With the aid of external pressure, the more direct and indirect irradiation of the parametrial fields at close range is facilitated, and in less-advanced cases the radium capsules can be expanded far beyond and behind the primary lesions in the cervical os.

3. Since all the radiation sources are incorporated within a single applicator, complete fixation of the individual multiple radium sources is assured. This feature is absent when capsules are indiscriminately packed against the cervical os.

4. Another advantage of this single-unit method of bringing the radium toward the fornices is the decentralization feature for correcting, or at least modifying, the position of the displaced cervical canal to a more central position, thereby increasing the vulnerability of both the primary lesion and the parametrium to the radiation sources, due especially to the incorporated expanding type of lateral colpostats.

5. Because of its practical simplicity and time-saving features, this method of applying radium is ideal for the fractional dosage type of irradiation. Frequent applications require relatively little preliminary preparation, especially after the initial cervical canal dilatation.

6. Injury to the bladder and the rectum is minimized due to the design and mechanical features of the lead-filled ends of the vertical radium capsules.

7. The more recent method of studying the combined distribution intensities of the linear sources of radium on slow photographic films, and the published contact and depth measurement charts previously mentioned have been most helpful for comparison of the effectiveness of this method with those employed heretofore in the treatment of cancer of the cervix.

8. There has been a tendency on the part of many radiotherapists and surgeons, to assume a certain degree of false security and, without further investigation, to attribute their recurrences or failures solely to the increased resistance or non-radiosensitivity of the tumor cells. In reviewing our past failures and early recurrences from a clinicopathological standpoint, with special reference to the radiation changes and lethal effects in removed uterine specimens, we have reached the conclusion that *unequal distribution of the radium sources*, inherent in many application technics, has been an equally important contributing factor in many of our past failures to eradicate completely all live tumor rests in the parametrial pelvic fields.

9. Unequal distribution of the radium sources within the cancer fields or the surrounding normal structures of the pelvis creates a clinicobiological irradiation hazard.

10. Future clinical evaluation, contrary to our accepted physical concepts, might indicate the desirability of decreasing the total gamma roentgens per milligram hour radiation intensity exposure in the *cervi-*

*cal uterine stem* in relation to the total dosage of the *vaginal fields*. Or it might prove desirable to increase the filtration of the lateral colpostats, or even to alter slightly the relationship or capsular spacing between the vertical and horizontal cervical canal planes of irradiation, even though our measurement studies indicate uniform distribution of the radiation sources in the present cross-arm arrangement.

11. From a clinical research standpoint, this method facilitates the more accurate comparison and clinical evaluation of the relative effectiveness of various methods of radium application in relation to the time and intensity factors of the total radium dose.

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SUMARIO

## Probables Tendencias en la Radioterapia del Carcinoma del Cuello Uterino con los Perfeccionados Aplicadores de Radio de Tipo Expansivo

Preséntase un aplicador perfeccionado de radio de una sola unidad que permite aumentar la efectividad del radio en los campos paramétricos al tratar el cáncer del cuello uterino (véase también RADIOLOGY **49:** 425, 1947). La ventaja técnica de este aplicador radica en su mecanismo de expansión regulada y la distribución exacta de siete a nueve fuegos cruzados de focos de radio en el interior de la pelvis. Con su propiedad expansiva, cápsulas laterales y colpostatos auxiliares, obtiénese una distribución mucho más amplia y uniforme de la irradiación y se aminora el peligro de la hiperirradiación de ciertas zonas de la bóveda vaginal. También se evita el desplazamiento de los focos de radio y se facilita la repetición de un plan terapéutico dado.

Otra ventaja consiste en la posibilidad de modificar la posición de un conducto cervical desplazado, a fin de irradiar más eficazmente la lesión primaria y los potencialmente cancerosos parametrios.

El relleno con plomo de los extremos de las cápsulas verticales de radio sirve de protección contra las lesiones irradiatorias en la vejiga y el recto.

Los estudios de la intensidad de la irradiación en películas fotográficas lentas han revelado que esta técnica de aplicación de radio se compara favorablemente con la de Manchester, sin adolecer de las dificultades técnicas de la ultima.

Desde el punto de vista de la investigación clínica, esta técnica facilita la comparación más exacta y la valuación de la relativa efectividad de varias técnicas para aplicar radio en relación con los factores tiempo e intensidad de la dosis total de radio. Debido a la sencillez y facilidad con que se aplica y al ahorro en tiempo que permite, el aplicador descrito parece ideal para la curieterapia de dosos fraccionadas.

## DISCUSSION

(Papers by Bowing; Twombly and Chamberlin; Caulk; Waterman; Costolow; Ernst)

**James A. Corscaden, M.D.** (New York City): It is a privilege to discuss this symposium, which I think is very important. It is important because of the frequency of the disease with which it is concerned, which in incidence is second only to cancer of the breast, as represented by the reports of New York State, the accessibility of the lesion, and its curability.

The thing that struck me more than anything else was that the results from the treatment of carcinoma of the cervix were closely correlated with the intensity of effort; that whether the patient was treated by intracavitary radium and x-rays, transvaginal x-ray irradiation, or interstitial radium therapy, in the early cases one should expect about a 70 per cent five-year survival and an absolute cure rate of something like 40 per cent. I think that has been brought out here today. Dr. Bowing showed 48 per cent absolute cures, not in 1915 but using the type of treatment which one might expect to receive today; and it is the same way with the vaginal cone technic, and with Dr. Waterman's treatment by interstitial radium.

I would like to concentrate on the early cases in our efforts to improve the therapy of cancer of the cervix, hoping that the neglected cases—and I think we ought to call them that—will receive the best palliation, with hope of an occasional cure. We should therefore discuss those cases in which there was a fair show for the treatment given. Here we immediately run up against the incidence of lymph node involvement. Some 20 to 25 per cent of these early cases have lymph node metastases, which, of course, is the principal occasion for the operative approach. Unfortunately, the operative approach is mechanical, but metastasis I do not think is a mechanical process; it is something biological, something in the behavior of the cancer cell which makes it capable of surviving in the body fluids, or whatever it may be, until it lands at some spot where it grows again.

Wertheim early came to that conclusion. He abandoned node dissection because to him it seemed that where the regional nodes were involved, there was also involvement of distant nodes. Whether our present more extended operations will give us better results remains to be seen. The essential fact is established that enormous dissections can be carried out with complete safety. Dr. Meigs and others with similar skill and facilities for the care of patients can report practically no mortality. The final results await further investigation.

There is one fallacy that I think comes into this discussion, and that is the radioresistance of the pelvic lymph nodes. I think Dr. Quimby has often brought out that very few lymph nodes have been irradiated. Putting a radium capsule somewhere in the neighborhood, or pointing an x-ray tube at this region, does not mean that the node has been irradiated, and, from what I can gather, with most of the technics used, these nodes do not receive enough radiation to produce effects upon which a proper judgment can be made. There is indirect evidence that at least some of the nodes are susceptible.

Comparing the different technics, I believe, as I have said, that it is a matter of intensity of effort. If one strives to get the proper number of roentgens or gamma roentgens, whichever his technic, his results will be better.

The intracavitary method seems to be a little on the defensive because of the calculations in physics. In the graphs that Dr. Nolan has shown, one notes intense radiation in the mid-line, diminishing rapidly laterally; nevertheless, 48 per cent absolute five-year survivals (1935–39). Dr. Bowing's experience is impressive. I think the pragmatic approach comes first. We can theorize as much as we want afterwards.

Interstitial irradiation has attracted my fancy, and I must say that theoretically it is an excellent method. One can get maximum radiation in the tumor area, diminishing rapidly toward the hollow viscera. The dose can be what we like; it can be thousands or hundreds if we put the needles where we want to put them, and we think we can. We have put 100 milligrams into the pelvis for 120 hours, giving only 10,000 gamma roentgens to lateral areas, 12,000 to the pericervical region, and 10,000 to the cervix.

I would like to make just one comment about the transvaginal cone before I stop. In our institution we have not had luck in applying the narrow lead-lined tube to multiple fields. Practically all the intravaginal work is through the single field. That is all I would care to say because I am a rank outsider when it comes to the matter of x-rays.

I would like to say, in summary, that if we will work hard, we will get better results. We are having a lot of fun, we technicians, but the real heart of this problem is getting the patient in. If we limit our activities to that which is technical, we are neglecting the great function which we could have as medical citizens, because it is through us, who are interested in cancer, that the laity will finally become convinced that the disease is curable. In my opinion, the greatest hindrance to the patient coming in is that she still thinks it is useless. As an example of this, at an eight-year follow up, a Professor of Economics,

a Ph.D., when congratulated on the result, replied: "Is it ever really cured?"

**Joe V. Meigs, M.D.** (Boston, Mass): I am a rank outsider, also. I am much interested in the surgical aspect of this problem, but I think the radiologic aspect, as expressed here this afternoon, is much more important. The treatment of cancer of the cervix is and should be radiologic at the present time. Like Dr. Corscaden, I am much impressed with the fact that almost all reports, stage for stage, give about the same percentage of cures. Those that are better than others are those that are carried out by individuals. I know Dr. Waterman and his work, and I know that he does most of it himself.

As roentgenologists or radiotherapists and as surgeons we have missed a lot. Each clinic ought to have all the tools it needs, and I am sure most radiotherapists in this room do not. Radium, radon, intravaginal cones, 100-, 200-, 1,000-, and 2,000-kv. machines are available; gold seeds and various kinds and shapes of metal needles are available, but we don't have them. In most clinics we have to use 10-, 12-, 25-, or 50-mg. needles, and the wonder is that we have as good results as we do. I think that is because of the meticulous care each man gives to his treatment.

There are certain newer methods of treatment that I think are important. We in our hospital—and I think it is only fair to refer to our own hospital, because we know about it—feel that early cancer of the cervix can be operated upon safely and well with very good results. We think at the present time that the more advanced cancers of the cervix or poorer-risk patients are better treated by x-rays and radium. In our experience a number of early cases which have been treated with x-ray and radium have not responded. Nodes have been found to be positive after treatment. In other early cases in the poor-risk group we feel that radium should be given and then, if the vaginal smear is negative after three months, that a retroperitoneal lymph-node dissection or Taussig operation should be done. In the more advanced cases or neglected cases I believe x-ray and radium to be the proper treatment. That is our belief and that is what we are going on.

We have been discouraged in our hospital to find that we cannot obtain an absolute measurement of dosage to the cervix; there is no method to date that we know of—maybe you x-ray men will deny it—by which we can actually measure the amount of radiation received by the cervix. That is fundamentally wrong. We think that soon we may have an instrument which will give an accurate measure of the tumor dose for the first time.

I think that Dr. Twombly is wrong. I pick on him because he has shown that he delivers 1,500 mg. hours in the region of the iliac and hypogastric nodes, and I don't believe 1,500 mg. hours sufficient to cure cancer in lymph nodes. Also, it is impossible to hit a partridge if you don't aim a gun at it, and there is no way you can direct an intravaginal cone at a lymph node. I believe the only way to treat nodes is by surgery. We know from my 100 surgical cases that in 21 per cent of the very early cases the nodes are positive. I think we are defeated in this group before we start x-ray treatment.

**Franz Buschke, M.D.** (Seattle, Wash.): We have witnessed this afternoon a very important symposium. The papers reflect the multiplicity of technics that have been used in an effort to improve the curative results in carcinoma of the uterine cervix. Each one of these papers deserves a careful critical analysis and discussion. This is obviously impossible within the time limits at my disposal and I shall therefore limit myself to some remarks in regard to the place of supervoltage roentgen rays in the treatment of cervical carcinoma, the importance of which Dr. Friedman stressed in his presentation.[1]

Dr. Cantril and I have recently surveyed the material of 275 cases of carcinoma of the cervix (excluding carcinomas of the stump and postoperative uncontrolled disease), treated with 800 kv since 1935, first by our predecessor, Dr. John Wirth, and since 1939 by us. In 172 cases for which five-year observations are available, we found our five-year cure rate essentially the same as that obtained at the Institut du Radium with similar radium technic and 200-kv. external irradiation. Our five-year rate in Stage II is 55 per cent compared to 49 per cent obtained in Paris, and for Stage III, 32 per cent against 36 per cent, which means a statistically insignificant difference. This failure to improve on the results obtainable with medium-volt irradiation in the control of the parametrial disease becomes understandable if we analyze the physical and biological factors involved. It is interesting to note that the percentage of failures in each stage of the disease corresponds fairly well to the percentage of microscopic lymph node involvement found in surgical specimens. This would suggest the possibility that the controlled cases represent the ones without lymph node involvement, while those with carcinomatous invasion of the pelvic nodes are largely incurable. A consideration of the physical factors of treatment seems to support this assumption. Physical measurements on a phantom by Dr. H. M. Parker, which were discussed in more detail at one of the previous meetings of this Society, have shown that with a total radium dose of 8,000 mg. hours and 3,500 r (measured on the skin) to each of four portals, with 800 kv. radiation, the combined contribution

[1] For future publication.

by radium and x-rays in the region of the obturator lymph node amounts to a maximum of 4,500 to 5,000 r, depending on the size of the pelvis and vagina. We do not expect an epidermoid carcinoma to be controlled by this dose administered in six or eight weeks, much less if it is lodged in a lymph node. Considerably higher doses in general do not control lymph nodes secondary to carcinoma of the oral cavity.

An increase of the dose beyond that mentioned is not possible because of the intolerable effects on the pelvic connective tissue and the intestinal mucosa. We have seen severe accidents, some of them lethal, when higher doses were used.

I do not mean by these remarks to deprecate the advantages of supervoltage roentgen therapy in general for properly selected cases or in the treatment of cervical carcinoma. The treatment is tolerated considerably better; there is less morbidity due to the treatment itself and, if it is properly conducted, the permanent by-effects and sequelae are reduced. If available, it therefore has definite advantages, but in our experience it has so far not improved the permanent curability of cancer of the cervix and for biological and physical reasons probably cannot be expected to do so significantly.

One of the inescapable conclusions of this afternoon's symposium seems to me the realization that none of the diversified procedures discussed has accomplished results superior to those obtained twenty years ago by the Radiumhemmet and Institut du Radium, in spite of the great effort and skill reflected in the papers presented. Does this not perhaps indicate that biological rather than technical limitations determine the possible accomplishment of radiation therapy? We believe that, as in other epidermoid carcinomas, the disease in general becomes uncontrollable when lymph nodes are invaded. The cures accomplished in Stage III and occasionally in Stage IV are more likely obtained in those cases in which there is a diffuse parametrial infiltration rather than lymph node involvement, or in which the palpable infiltration is of an inflammatory or fibroblastic reactive nature rather than due to invasion of cancer.

I do not wish to have this interpreted as a defeatist attitude, but a realization of this fact may perhaps lead us to concentrate more on efforts in the three directions which can improve results—namely, the treatment of earlier cases; the elimination of those technics which are charged with an unnecessarily high risk of permanent radiation damage or which fail to control any appreciable number of primary foci in the cervix itself; and a more thorough training of radiation therapists in skillful individualized application of those procedures which during these twenty years have stood the test of optimal usefulness. Then the results of treatment of cervical carcinoma in general practice will more nearly approximate those obtained in the few pioneering centers than they do today.

**Harry H. Bowing, M.D.** (*closing*): Statistical material is usually complicated and disturbing, especially when presented hurriedly. It is disconcerting to learn that the data contained in the tables were confusing. A real endeavor was made to avoid an intricate discussion. The treatment technic employed has been reported through the years and has remained fundamentally unchanged. It is designed for cure or palliation. Time permitted only a very brief statement concerning the procedure. The same statements may be made regarding the method of classification of patients. Patients who have lesions of Stage I or II are favorable for cure; those who have lesions of Stage III have a less favorable chance of cure, whereas those with Stage IV lesions are usually treated with palliation only in mind. The anatomic extent of the primary lesion is the essential feature in grouping cases according to the stage of involvement.

**Gray H. Twombly, M.D.** (*closing*): I think wherever I have heard discussions of the treatment of cancer of the cervix, at least one person has made the statement that the results obtained in various clinics are all the same. That is really not so.

Last Spring I heard four papers in which four competent men reported five-year survivals of 55 per cent, 45 per cent, 33 per cent, and 19 per cent, and those men were equally competent. Their results differed not because one was uninterested and another was interested in the treatment of cancer of the cervix, but because their material differed when they started to work on it. One was dealing mostly with early cancer; another with advanced cancer.

If we are going to compare the results of one clinic with another—and I think this is tremendously important in order to arrive at the best methods of treatment—we must try to talk the same language. I was impressed here today by the fact that several of the people presenting papers were not familiar with the present League of Nations classification of cancer of the cervix. There is a very good little atlas prepared by the League of Nations which pictures in black and red the extent of the various classifications of cancer of the cervix, and I think anyone treating cancer of the cervix ought to own that book and ought to study it.

With that somewhat acrimonious statement, I would like to go on to say that in our experience the treatment of Stage III and IV cancer of the cervix by radiation therapy is exceedingly discouraging. The latest figure that we have on Stage III is 7 per cent three-year cures. We have not succeeded yet in treating and curing a Stage

IV cancer of the cervix, by which I mean one with actual invasion of the bladder or rectal mucosa by tumor or with metastasis outside the pelvis. I suggest to Dr. Meigs that they might be very good cases for surgical therapy, since radiation cannot do anything for them and I think maybe surgery can.

Finally, when Dr. Meigs says that in order to hit a bird you have to shoot at it, I agree with him. I thought that, in my pictures in which the lymph nodes were marked, I did show that we were aiming at the bird even though it might be a long shot.

**Ralph M. Caulk, M.D.** (*closing*): It has been a privilege to appear on this program this afternoon. The discussants have been rather kind to all of us.

I would like to echo what Dr. Twombly has just repeated, that it is very difficult to compare the work in the various clinics. In preparing my paper, I reviewed all the recent literature and I found it almost impossible to compare what I had done with the work of anyone else. The paper I prepared for presentation this afternoon is the third paper I know of reporting figures by the revised League classification. The first was by Dr. Healy in 1943, and the last one was by Dr. Twombly in 1946.

I do think this, that cases should be reported finally in terms of absolute survivals. The number of cases that are accepted for treatment consecutively, as they come, without selection, should be the denominator for the total number of survivals. If this is done, the percentages of controls emerge more nearly in their true perspective. Survival results become markedly prejudiced when one loses any considerable number of cases for lack of follow-up and does not admit them to statistical evaluation.

**George W. Waterman, M.D.** (*closing*): I just want to say that I have thoroughly enjoyed the symposium this afternoon. It has been a great pleasure to hear the varying ideas as to treatment that have been expressed so well. I haven't anything further to say in discussion except that I would like to correct Joe Meigs on one point and tell him that I do not treat all of the cases at the Rhode Island Hospital personally. Dr. Pitts is still active and treats many of them privately, and Dr. Ralph DiLeone, my assistant, treats fully half of them. I want to assure you that the Rhode Island Clinic is not a one-man show.

**Edwin C. Ernst, M.D.** (*closing*): This has been a most important meeting, which could be entitled, "Information Please by the Experts." While this information is of interest to the experts in the audience, we must realize that the greater number of cancer cases are observed by average physicians and surgeons who do not have all of the available complicated and expensive therapy apparatus or special hospital facilities. The application of radium likewise must be classed as a special therapy procedure and, unfortunately, is not always done to the best interest of the patient, even in our larger hospital centers, when there is a lack of co-operation between the radiological and gynecological departments.

In closing, I merely wish to emphasize one point: namely, that greater attention should be directed to the equal distribution of the radium intensities to meet the individual requirements of the clinical problem. If uniform intensity and spacing of the radium sources are employed as a routine procedure, then the advantages of different timing and dosages can be better analyzed. We are then speaking the same language and eventually will be in a better position to compare and improve our methods of radiation therapy.

# The Cervical Subarachnoid Space, with Particular Reference to Syringomyelia and the Arnold-Chiari Deformity[1]

JOSEPH H. MARKS, M.D.[2] and KENNETH E. LIVINGSTON, M.D.[3]

Boston, Mass.

IT IS THE OBJECT of this paper to call further attention to the subarachnoid space in the cervical spine. We believe that insufficient attention has been paid to this area in the past and that helpful information may be obtained by its study. A review of the literature suggests that less than 20 per cent of spinal cord tumors show evidence of their presence on films made without contrast media. We are aware of the fact that 80 to 85 per cent of such tumors may be diagnosed by myelographic studies employing opaque media; but we believe that an appreciable number may be demonstrated without subjecting the patient to that procedure. The contrast afforded by air or oxygen is very much less than that provided by lipiodol or pantopaque, but with careful technic it may nevertheless be adequate and possible complications which may arise from residues of oil in the basal cisterns or elsewhere in the spinal canal may thus be avoided.

Fig. 1. Sagittal section of skull showing the free communication of the subarachnoid spaces of the cranial cavity with those of the spinal canal. From "The Head and Neck in Roentgen Diagnosis," by Pancoast, H. K., Pendergrass, E. P., and Schaeffer, J. P. Reprinted with permission of the publisher, Charles C Thomas, Springfield, Ill.

The subarachnoid space which surrounds the cervical cord is of sufficient volume to permit the collection of an appreciable amount of air or oxygen around the cord

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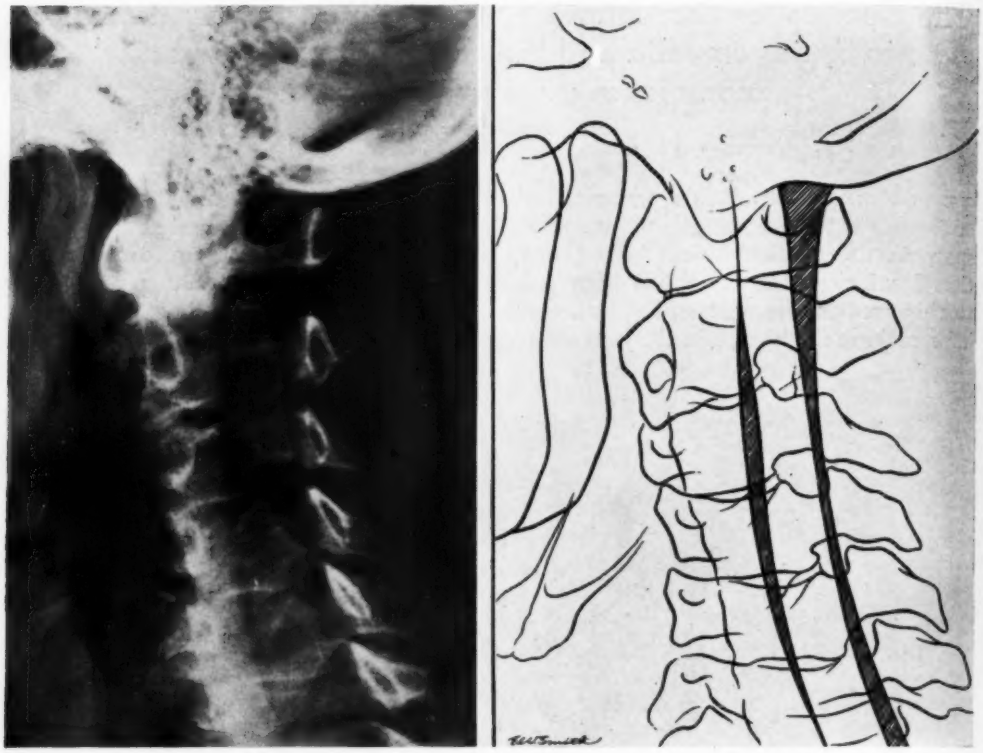

Fig. 2. Normal cervical cord and subarachnoid space.

after withdrawal of the cerebrospinal fluid by means of lumbar puncture. This sleeve-like collection of gas is shown on lateral or oblique films as a line of diminished density lying anterior and posterior to the cord. The column of gas thus serves to delineate the spinal cord and to indicate not only its position within the canal but also its size. We have not been able to demonstrate it on anteroposterior films because of the density of the vertebral bodies.

The normal spinal cord passes through the foramen magnum somewhat anterior to the center of the foramen, but is then directed slightly posteriorly, so that below the level of the second cervical vertebra it occupies an approximately symmetrical position within the canal. In the adult, the cord has a fairly constant diameter of about 1 cm. at the level of the atlas and axis. Below this there is a gradual increase in size to accommodate the cell bodies for the large number of nerves which go to the upper extremities. The enlargement is almost entirely in the transverse diameter of the cord, and (in the neck) is greatest at the level of the fifth and sixth cervical vertebrae. On films taken as indicated below, the diameter of the normal cord at this level averages 12 to 13 mm.

It must be remembered that the spinal subarachnoid space is in direct communication with the subarachnoid spaces and ventricular system within the cranial cavity. In the normal subject this communication is of greatest caliber posterior to the cord as it passes through the foramen magnum. The portion of the spinal subarachnoid space which lies posterior to the cord is thus a direct extension

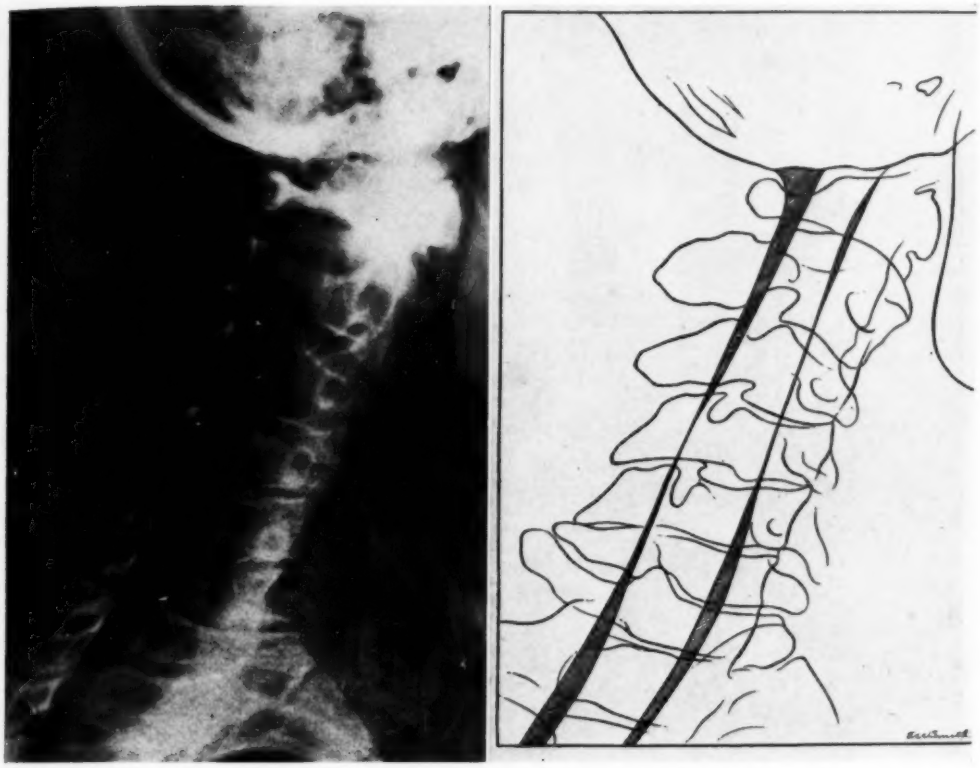

Fig. 3. Syringomyelia. The patient was a 44-year-old man who had had pain in his right wrist, and to a lesser extent in the entire right upper extremity, for about eight years. Physical examination showed a rather severe degree of atrophy of the muscles of the right arm and hand. The atrophy was less marked on the left side, but there was swelling of the left elbow associated with a neuropathic joint. There was loss of pain and temperature sense from the upper cervical to the lower thoracic level, with absence of reflexes in the upper extremities, a Horner's syndrome, and a fine nystagmus. Spinal fluid protein was 56 mg. per cent. Encephalograms demonstrated a rather extensive swelling of the cervical cord. The diagnosis of syringomyelia was confirmed at operation two days later. The cavity contained more than 15 c.c. of fluid.

downward of the cisterna magna; it is unfortunate that this cistern is frequently defined as having its inferior border at the level of the foramen. Within the arches of the atlas and axis, the subarachnoid space is of relatively large volume and posteriorly it is approximately the shape of an inverted, bisected cone. The cerebellar tonsils may be demonstrated in this space when they are displaced downward as a result of increased pressure from above, and they occupy this same position in the syndrome described by Arnold (1) and Chiari (2).

Studies of the cervical cord by air myelography were reported by Lowman and Finkelstein (3) in 1942. They were able to demonstrate an intramedullary glioma at the level of the second cervical vertebra and an extramedullary mass of Hodgkin's disease which extended from the level of the second to the fifth cervical vertebra but did not involve bone. They called attention to the cervical extension of the cisterna magna and made measurements of the normal cervical cord at various levels. Their measurements were made on true lateral films which had been exposed in the erect position. Their illustrations suggest, however, that helpful information may also be obtained from other than true lateral views.

In our department the encephalographic routine includes anteroposterior and pos-

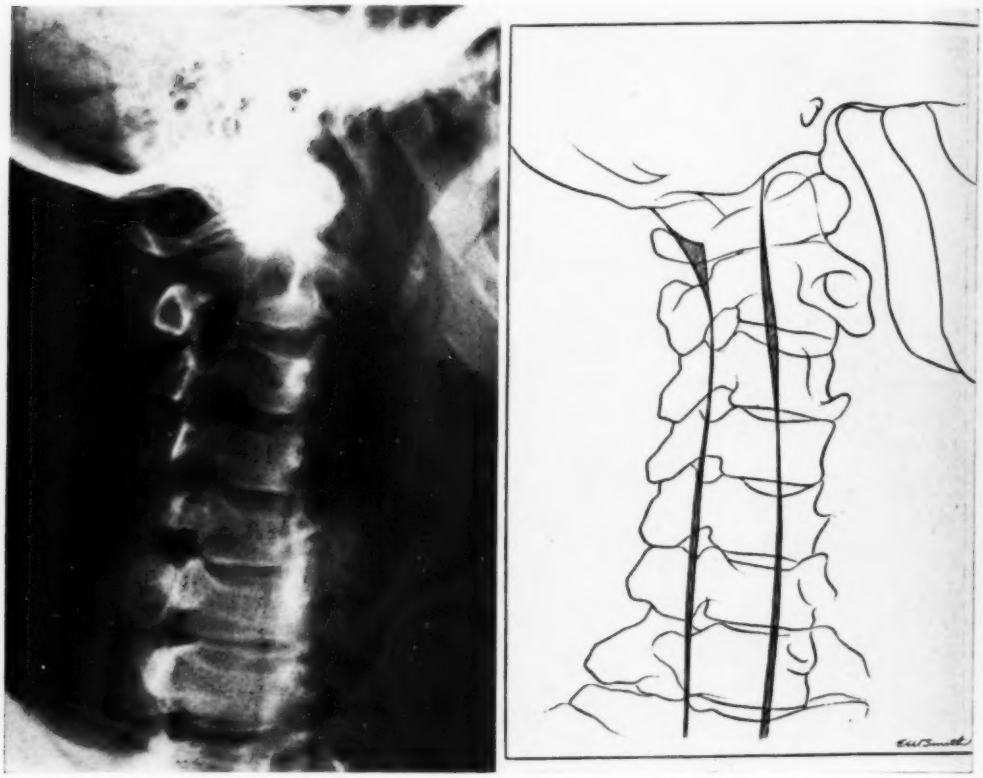

Fig. 4. Arnold-Chiari deformity with hydromyelia. The patient was a 42-year-old woman whose present illness began three years before, when she first experienced pain in the region of the right scapula when coughing. A few months later she noted loss of temperature sense in the right arm and had since burned herself many times without pain. Physical examination showed loss of pain and temperature sense in the right upper extremity, with slightly less than normal temperature sense over the entire right side of the body except for the face. Biceps and triceps reflexes were absent on the right, but there was no weakness of the muscles. Spinal fluid protein was 37 mg. per cent. Encephalograms showed a soft-tissue mass extending down through the foramen magnum to occupy the space behind the upper cervical cord. There was also some swelling of the cord. At operation the cerebellar tonsils were found to extend down to the upper border of the third cervical vertebra, and within the cord there was a hydromyelic cavity from which about 10 c.c. of colorless fluid was aspirated.

tero-anterior single films, with right and left lateral stereoscopic pairs. All routine films are made with the patient on the table and with an overhead tube. For the lateral films the patient is prone, with the head turned toward the side. Additional films are obtained in other positions when desired. Lateral exposures are made on 11 × 14-inch films, so that the major part of the cervical spine is seen on almost all stereoscopic views. It is obvious that, with the patient so positioned, the exposure of the cervical spine is in varying degrees of obliquity. It is our belief, however, that in most instances these films afford satisfactory visualization of the cervical canal, providing an adequate amount of oxygen has been injected and the x-ray exposure is correct. It must be noted that with too heavy exposure the thin column of oxygen cannot be seen well. The films are best studied in a dimly lighted room with closely shielded illuminators. Since the density differences are not great, they are more evident in the stereoscopic pair than in a single film. A spotlight is frequently helpful. The collection of oxygen in the cervical subarachnoid space may be adequate for study of this region even when the filling of the ventricular system and/or the sub-

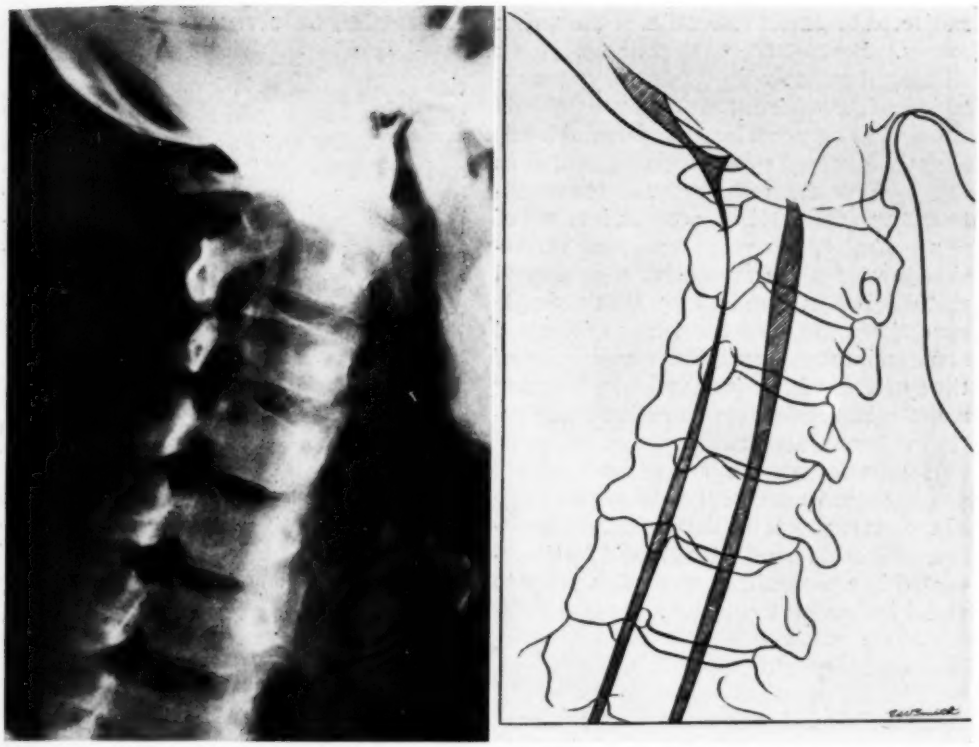

Fig. 5. Arnold-Chiari deformity with platybasia. A 25-year-old man was admitted to the hospital because of pain in the back of his neck of two years duration. The pain was made worse by lifting or straining. The attacks lasted for two or three minutes and were severe and steady, associated with some vertigo and nausea, and occasionally with vomiting. There was no loss of consciousness. Physical and neurological examinations were negative except for congenital anomalies of the hands and feet, and for a persistent hyaloid artery in the right eye. Spinal fluid protein was 18 mg. per cent. Skull films showed platybasia, and encephalograms showed herniation of the cerebellar tonsils. These findings were confirmed at operation, at which time the posterior margin of the foramen magnum plus the arches of the atlas and axis were removed. The dura was incised and was left open.

arachnoid spaces over the cerebral hemispheres is unsatisfactory, and, in fact, it frequently is unsatisfactory in patients with abnormalities of the cervical canal.

The diameter of the cervical cord as depicted on films taken according to this technic is greater than that determined by Lowman and Finkelstein (3) and the amount of difference increases from above downward. This is due to the fact that the transverse diameter of the spinal cord is greater than its anteroposterior diameter, and also to the fact that it is an oblique diameter of the cord which is projected on our films. We do not believe that this variation in technic is of any importance, since a set of normal measurements may be readily obtained for either method.

The cases illustrated (Fig. 3–5) include syringomyelia, the Arnold-Chiari syndrome, and displacement of the cerebellar tonsils by pressure from above. To date we have not demonstrated an extramedullary cervical cord tumor by oxygen myelography, but can see no reason why that might not be done, since such a lesion has been demonstrated in the thoracic spine.

The patients were under the care of the Neurosurgical Service of the Lahey Clinic, and all operative procedures were carried out by its members. Dr. James L. Poppen of that department has been particularly interested in study of the cervical subarachnoid space as an aid in clinical diagnosis.

During the period included in this study 6 cases of typical syringomyelia have been

subjected to simple aspiration of the syrinx cavity. Four of the patients have shown striking, but probably temporary, neurological improvement. This neurologic change has occurred in the segmental levels directly involved by the disease, as well as the long tracts affecting the lower extremities. One patient, after an interval of approximately one year, is showing regression toward his preoperative neurological status. It therefore appears that a simple operative procedure consisting of limited hemilaminectomy and direct aspiration of the syrinx has been as effective in inducing neurological improvement as has more extensive formal laminectomy.

If an effective method of maintaining prolonged or permanent internal drainage of the cavity could be developed, the progress of disability might be significantly retarded in cases which respond favorably to an initial, simple aspiration.

SUMMARY

We believe that the roentgen examination of all patients having encephalograms should include lateral stereoscopic films of sufficient size to show the cervical canal and that study of this area may occasionally yield valuable information. Herniation of the cerebellar tonsils, syringomyelia, and spinal cord tumors may be demonstrated without the use of opaque media.

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SUMARIO

**El Espacio Subaracnoideo Cervical, con Referencia Particular a la Siringomielia y la Deformidad de Arnold-Chiari**

Llámase la atención sobre el espacio subaracnoideo de la porción cervical del raquis y sobre la importancia que reviste el examen del mismo. Los estudios encefalográficos deben comprender estereorradiografías de tamaño suficiente para revelar el conducto cervical. Este será visualizado satisfactoriamente en la mayor parte de los casos, con tal que se haya inyectado una cantidad adecuada de oxígeno y que la exposición a los rayos X sea correcta, evitando así la necesidad de echar mano a la mielografía con medios opacos.

Tres casos son descritos sucintamente con ilustraciones, comprendiendo siringomielia, deformidad de Arnold-Chiari y desplazamiento de la amígdala cerebelar por la presión desde arriba.

# Intraventricular Epidermoid

## Characteristic Pneumoencephalographic Findings[1]

HARRY HAUSER, M.D., and CHARLES W. ELKINS, M.D.
Cleveland, Ohio

EPIDERMOIDS ARE rare tumors which occur either extradurally in the diploë of the skull or as intradural lesions involving various portions of the brain and occasionally the spinal cord. According to Bennett (3), the incidence of epidermoids of the central nervous system at the Army Institute of Pathology was 5 cases in 518 brain tumors or 0.96 per cent. He quotes other statistics which indicate a variation in incidence from 0.37 to 0.6 per cent. These lesions are often referred to as cholesteatomas and pearly tumors because they usually contain large amounts of cholesterol and, when encountered at operation, grossly present a mother-of-pearl sheen. The term epidermoid is preferred because it is believed that the tumor arises from embryonic epithelial rests (7) and is not merely the result of epithelial debris such as is found in the middle ear and mastoid region.

There have appeared in the literature many reports (1–5, 7, 10, 11, 13, 14, 16,) indicating that diagnosis of the intracranial lesions is seldom made preoperatively and that many of them are incidental findings postmortem. The extradural or diploic epidermoids are often diagnosed before operation by the radiographic demonstration of a scalloped, sharply circumscribed destructive area in the skull (13).

The intraventricular epidermoids produce a characteristic pneumoencephalographic appearance, of which only 6 verified cases have been found in the literature. Krieg (12), in 1936, in a report of aseptic meningitis following operation in two cases of cholesteatoma, described in the ventriculograms of one case irregular circular dense shadows in the air-filled right lateral ventricle. In a footnote he stated that similar findings had been previously demonstrated by Olivecrona in ventriculograms which were typical for cholesteatoma. Dyke and Davidoff (9), in 1937, without the knowledge of Krieg's publication, reported a large epidermoid tumor located in the temporal and frontal horns of the right lateral ventricle with surgical removal and uneventful recovery. The air studies described were unique, showing globular and linear collections of gas in the area normally occupied by the thalamus, the island of Reil, and the right temporal and posterior portion of the frontal lobes. In addition, the left lateral ventricle was larger than the right, the body of the latter being elevated. The third ventricle was displaced to the left, and the right temporal horn was sharply cut off.

Weinberger (17), in 1938, made the diagnosis of an intraventricular epidermoid from the encephalographic appearance in an unproved case, and also reported a second case with characteristic air studies which had been operated on by Dr. Sydney W. Gross. The latter patient made an uneventful recovery, with only a residual slight speech defect. Weinberger described a curious filigree lacework of communicating channels of air and explained this as due to the air penetrating the numerous clefts or infoldings of the tumor as it lay in the air-filled ventricle. Dyke (8), in 1941, described a second case he had observed, in which the tumor was situated in the posterior thirds of the lateral ventricles. Encephalography revealed large irregular streaks of gas passing through the substance of the tumor and

[1] From the Departments of Radiology and Neurosurgery, Cleveland City Hospital and School of Medicine, Western Reserve University. Presented at the Thirty-third Annual Meeting of the Radiological Society of North America, Boston, Mass., Nov. 30–Dec. 5, 1947.

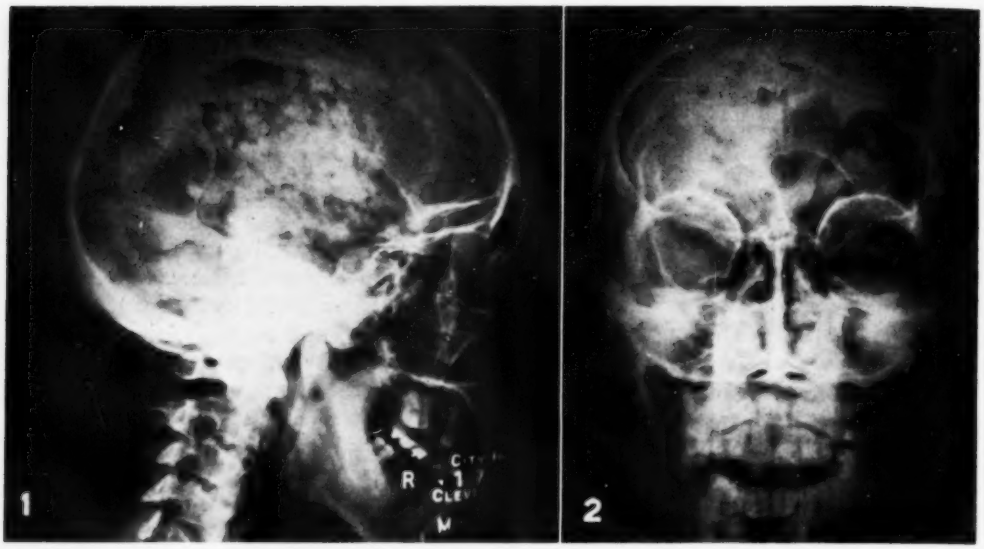

Fig. 1. Lateral view, showing irregular, streaky air shadows extending throughout entire left lateral ventricle
Fig. 2. Anteroposterior view, showing enlargement of the left lateral ventricle with sponge-like large oval tumor containing irregular air shadows in its periphery.

the area of the brain normally occupied by the splenium of the corpus callosum. Peyton and Baker (15), in 1942, reported 14 cases of epidermoid and teratomatous tumors of the brain and spinal cord, one of which was an intraventricular epidermoid. The air studies showed a large cystic area, filled partially with air and partially with tumor, situated in the region of the right parietal and occipital lobes, but extending far beyond the confines of the normal ventricle. Although the authors stated that only the left lateral ventricle was displaced to the left, the reproduction of the encephalogram reveals that the right lateral ventricle was also displaced to the left. Childe and Young (6), in 1946, reported the sixth proved case of intraventricular epidermoid with pneumoencephalographic diagnosis. The lesion was extensive, partially filling both lateral and third ventricles.

A seventh case of intraventricular epidermoid with characteristic pneumoencephalographic findings is reported here:

A. D., a white male aged 42, was admitted to Cleveland City Hospital on Feb. 23, 1947, complaining of difficulty in walking, pain in the feet, and numbness and weakness of the arms and legs for the previous four to five months. He had been well up to four or five months prior to admission, when he began to notice pain in the sole of the right foot accompanied by weakness and numbness of the right arm and leg. The condition was of fairly sudden onset, but had become progressively worse, so that at the time of admission there were numbness and weakness of the right side of the body and pain in the sole of the right foot. During the early part of this illness, the patient saw a physician, who gave him a "hip-shot." He worked until August of the same year, when the factory doctor advised his discharge because of his difficulty in standing. Two years previously, he had slipped, striking his head on the floor, but he did not lose consciousness. He suffered no apparent sequelae to this accident, and had had no other head injuries. He had experienced occasional left parietal headaches for the past two years. Recently, he had had difficulty in standing, tending to fall to the right. There had been no insomnia, vertigo, nausea, or vomiting. His memory had been good. Blood pressure was normal.

The patient had been in the hospital in October 1946, with a diagnosis of neoplasm of the parietal lobe of the left cerebral hemisphere. Refusing operation, he was released to his home, and his condition remained the same until his present admission.

On neurologic examination by Dr. L. J. Karnosh, the patient demonstrated a right homonymous hemianopsia, right spastic hemiplegia, right asyner-

gia, right hemihypesthesia, right amimia, and bilateral optic atrophy.

An electroencephalogram made on March 3, 1947, showed delta waves (4 per second, 60 m.v.) in the frontal and precentral regions on both sides, with phase reversal in the right precentral region. The conclusion reported by Dr. E. M. Zucker was record of organic type, with some evidence of localization in the right precentral region.

*Roentgen Examination:* Plain radiographs of the skull made on Feb. 28 failed to exhibit any abnormalities except for a questionable shift of the pineal body to the right. Pneumoencephalograms, however, made on March 5 revealed a unique configuration of the air shadows, in that there was a mottled and streaky appearance in the left temporal and parietal regions in the lateral view (Fig. 1). In the postero-anterior and anteroposterior views, both lateral ventricles were dilated, the gas appearing mottled on the left and homogeneous on the right (Figs. 2 and 3). Within the left lateral ventricle, a large oval-shaped mass surrounded by a layer of gas could be observed, with streaky air shadows coursing through its substance. On the basis of the recent article by Childe and Young, in the January 1947 issue of RADIOLOGY, a diagnosis of intraventricular epidermoid was made.

*Operation* (March 31, 1947) consisted of craniotomy, with partial removal of tumor. The head was prepared and draped in the usual manner, and an anterior central bone flap was turned down with its base underneath the temporal muscle. This procedure was accomplished by drilling several burr holes and connecting the incision by using Gigli saws. The dura was tense and upon opening it, with its base toward the sagittal sinus, the brain bulged markedly. A cortical incision was made in the precentral region, and the lateral ventricle was opened and found to contain a large, pearly white tumor which was obviously epidermoid. The body of the left ventricle was filled with the tumor, which was removed mainly by suction and by a brain spoon. It was thought impossible to remove the entire mass, although all was taken out that could be seen. The temporal horn of the left lateral ventricle was also observed to be filled with the tumor. At the completion of this procedure, the brain appeared markedly collapsed and pulsated only weakly. The dura was closed with interrupted fine silk and a subdural Penrose drain was placed in the wound. A second Penrose drain was inserted between the dura and the bone flap. The skin flap was sutured with two layers of fine silk and a head dressing was applied. (C. W. E.)

*Pathologic Report:* The specimen consisted of several pieces of grayish-white membranous tissue, the larger ones being convex on one surface and concave on the other. The largest piece measured 3.5 × 2.5 × 0.4 cm. Attached to some of the concave surfaces and lying loosely with the specimen were bits of friable, grayish and yellowish-white tissue having the characteristic odor of retained desquamated squamous epithelium or sebaceous material. A few of the bits, however, had a consistency and appearance suggestive of brain tissue.

Fig. 3. Postero-anterior view revealing bilateral internal hydrocephalus, with air shadows appearing mottled on the left and homogeneous on the right.

*Microscopic Description:* Sections revealed concentric layers of desquamated stratum corneum and a very thin curving wall of greatly compressed stratified squamous epithelium (Fig. 4).

*Diagnosis:* Epidermoid cyst (of brain, intraventricular). (Dr. R. C. Taylor)

The patient responded well following the craniotomy until the tenth postoperative day, when he became stuporous and there was marked temperature rise. The drains had been removed on the fifth postoperative day. It was believed that the bone flap was somewhat elevated to palpation. The patient was again taken to surgery and a postoperative clot of moderate size was removed from the extradural space. He did poorly following this procedure and died on the fifteenth day following the initial craniotomy.

## DISCUSSION

The purpose of this communication is to emphasize the importance of establishing an accurate diagnosis of a brain lesion such

TABLE I: PROVED CASES OF INTRAVENTRICULAR EPIDERMOID

| | Author | Age and Sex | Location of Lesion | Displacements and Shifts | Treatment | Result |
|---|---|---|---|---|---|---|
| 1. | Krieg | 35 F | Rt. lateral ventricle | Bilateral hydrocephalus | Surgical removal | Died 7 weeks postoperative |
| 2. | Dyke and Davidoff | 30 F | Rt. temporal and frontal horns. Rt. lateral ventricle | ..... | Surgical removal | Uneventful recovery |
| 3. | Weinberger | 39 M | Left lateral ventricle 1.5 cm. in frontal horn | ..... | Surgical aspiration | Recovery, with a slight speech defect |
| 4. | Dyke | | Posterior thirds of the lateral ventricles | ..... | ..... | ..... |
| 5. | Peyton and Baker | 67 M | Rt. lateral ventricle and posterior portion of left lateral ventricle | Pineal to left; ventricular system displaced to left | Surgical aspiration | Died 17 days postoperative |
| 6. | Childe and Young | 37 F | Both lateral ventricles and 3d ventricle | Hydrocephalus | Surgical removal | Died 5 months postoperative |
| 7. | Hauser and Elkins | 42 M | Entire left lateral ventricle | Hydrocephalus | Craniotomy. Partial removal by suction and spoon | Died 17 days postoperative |

as can be accomplished by pneumoencephalography in cases of intraventricular epidermoids. The literature on this particular phase of brain tumor diagnosis, as has been indicated, is relatively slight. Certain conclusions may be drawn from a study of Table I, which lists the reported proved cases with encephalographic findings, although the series is small. The age span, from the fourth to the seventh decade, probably indicates that any age may be affected. The sex distribution is equal. The lateral ventricles are most frequently involved, more often unilaterally. Epidermoids are known to occur in the third (6) and fourth ventricles (14), but cases with characteristic pneumographic findings have not as yet been reported. The treatment is surgical removal when possible, and in 2 of the 7 cases reported recovery occurred. In addition to the reticulated appearance of the air shadows, other signs of brain tumor were present, such as displacement of the ventricular system or pineal body to the opposite side. Enlargement of the lateral ventricles was observed in some cases, probably due to pressure on the aqueduct of Sylvius producing obstruction with resultant internal hydrocephalus.

The air shadows in the encephalogram or ventriculogram have been described as irregular streaks, filigree lacework of communicating channels of gas, reticular mass of air, and sponge-like mass of irregular collections of air. Weinberger (17) and Dyke (8) believe this appearance is explained by the distribution of gas in the folds of the walls of the tumor and that no other known brain lesion produces a similar picture.

## SUMMARY

1. Epidermoids are rare tumors occurring in the skull and cerebrospinal system, the incidence varying from 0.37 to 0.96 per cent of brain tumors.

2. Epidermoids in the diploë of the skull produce a scalloped, sharply circumscribed destructive lesion.

3. Intraventricular epidermoids produce a characteristic pneumoencephalographic appearance, 6 verified cases being found in the literature.

4. A seventh case of intraventricular epidermoid with characteristic encephalographic findings is reported in detail.

5. Irregularly shaped collections of gas with a streaky configuration are believed to be attributable to the infoldings of the wall of the epidermoid tumor lying in the ventricle.

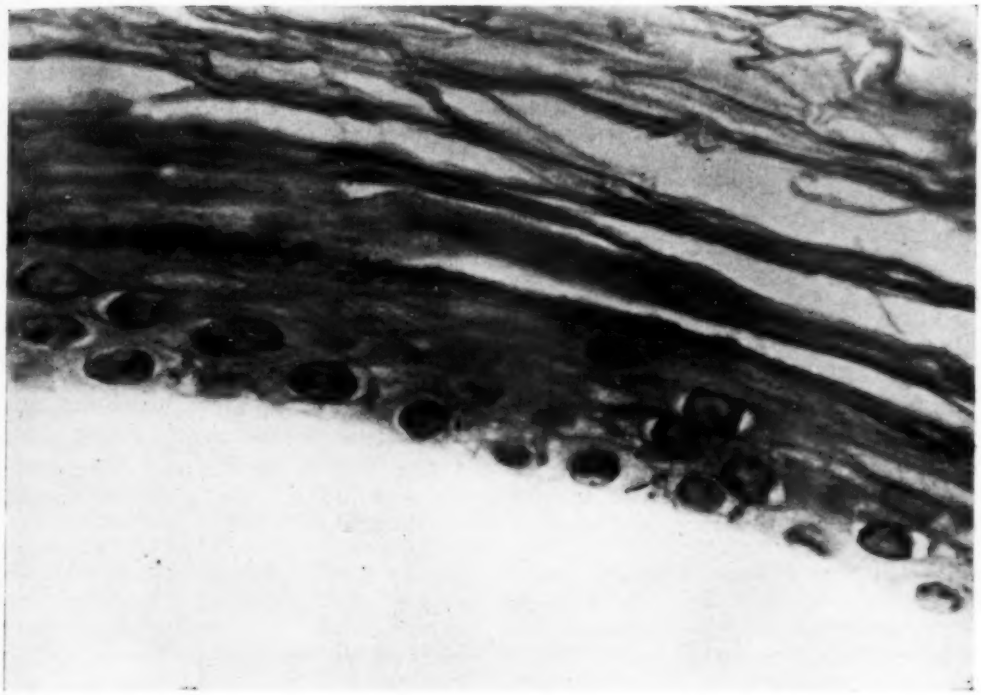

Fig. 4. Photomicrograph of small section of cystic tumor, showing concentric layers of desquamated stratum corneum and a very thin curving wall of greatly compressed stratified squamous epithelium.

6. Other signs of brain tumor, with displacement of the ventricular system and pineal body and internal hydrocephalus, may be associated with the characteristic streaky shadows observed in the encephalogram or ventriculogram.

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SUMARIO

**Epidermoide Intraventricular. Típicos Hallazgos Neumoencefalográficos**

Los epidermoides son tumores raros que se presentan bien fuera de la duramadre, en el diploe craneal, o en forma de lesiones intradurales que afectan varias partes del cerebro y a veces la médula espinal. Afírmase que constituyen de 0.37 a 0.96 por ciento de los encefalomas.

Los epidermoides del diploe craneal producen una lesión crenada, destructiva y bien circunscrita y son a menudo diagnosticados preoperatoriamente por el cuadro roentgenológico.

Los epidermoides intraventriculares muestran un típico aspecto neumoencefalográfico, habiéndose encontrado seis ejemplares comprobados en la literatura. Preséntase ahora el séptimo caso, tabulándose los hallazgos de los casos compilados. La característica sobresaliente es la presencia en el tumor de depósitos, de forma irregular, ya de aire o gas, y descritos, ya como estrías irregulares, filigrana de canales unidos, tumefacción reticular y masa esponjosa de aglomeraciones de aire. Dicho aspecto parece proceder de la distribución del aire o gas en las paredes envolventes del tumor. Junto con las características sombras estriadas puede haber otros signos de tumor cerebral, tales como desplazamiento del aparato ventricular y del cuerpo pineal e hidrocefalia interna.

DISCUSSION

(Papers by Marks and Livingston; Hauser and Elkins)

**Merrill C. Sosman, M.D.** (Boston, Mass.): The common denominator in these two papers appears to me to be dividends from careful study of anatomical details. That, I think, has been the development of a large part of our science of diagnostic radiology—care and attention to details, the correlation of findings, ending up with a diagnostic procedure and a contribution to knowledge such as we have had this morning.

Dr. Marks' slides unfortunately, even to me sitting in the second row, did not show the change in the cervical air space adequately, but I can assure you that it is present and is recognizable, and we always study that cervical air space in our encephalograms to pick up any unexpected lesions.

As to the paper by Dr. Hauser and Dr. Elkins, I think it should be emphasized that these epidermoids, which are often miscalled cholesteatomas, show very nicely and are quite readily recognizable when they involve the cranial bone, as they may do in a small percentage of the cases. They have the characteristic smooth, scalloped, dense outline, very frequently in the region of the outer end of the sphenoid wing. However, most of the intracranial epidermoids are in the brain and are not recognizable on plain x-ray examination. That may sound strange to some of you thinking radiologists, because these epidermoids are full of cholesterol crystals, and one would logically think that this would give an area of diminished radiance. As a matter of fact, it doesn't. When you do see an area outlined intracranially by an area of diminished radiance, it is usually a lipoma and not an epidermoid, and such cases have been reported in about the same incidence as these epidermoids. The only way to diagnose intracranial epidermoids not involving the skull is by encephalography and by recognizing the very peculiar lacework which has been shown here today.

It is certainly nice to see the refinement of diagnosis these days. It is interesting to go back a little bit and see how poor we were when Dr. Farmer and I worked together at Massachusetts General twenty-five years ago. We were able to spot or to recognize very few of the lesions which we now locate and identify with ease. Dr. Dandy's work on ventriculography and encephalography has been the greatest contribution to the diagnosis of intracranial tumors in our lifetime.

# Diagnosis of Primary Hodgkin's Disease of the Stomach[1]

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PRIMARY HODGKIN'S disease of the stomach is a rare condition. A search of the literature reveals that approximately 22 cases have been reported up to the time of the present writing. The case to be included in this report will bring the number to 23. Of these cases, only one is claimed to have been diagnosed preoperatively, namely, the second of two reported by Browne and McHardy (1) in 1946. Among these 22 cases, approximately 16 were treated by surgical means, mainly total or subtotal gastric resection and, so far as can be determined, all those that survived the immediate postoperative period have continued to live without definite evidence of recurrence (2), indicating that if this disease can be diagnosed preoperatively it should call for immediate extensive surgery. In other words, the presence of a very extensive lesion of the stomach, in some cases involving almost the entire organ, should not be a deterrent to radical surgery, in spite of the usual hopeless prognosis of extensive gastric carcinoma. The authors made this very mistake in the case being reported in this article.

It is believed that cases of Hodgkin's disease primary in the stomach seen from time to time are diagnosed radiologically as extensive infiltrating carcinoma, with a hopeless prognosis, and the patients are sent home to die. As a result, autopsies are not performed, so that the true condition is never ascertained.

A few characteristics stand out, both in the authors' case and in the cases reported, that should be pointed out to radiologists in the hope that they may be made more suspicious of the possibility of this lesion and that the number of exploratory laparotomies may perhaps be increased.

The principal criterion that we have noted consists in the presence of polypoid-like masses along the course of the involved area of the stomach. Apparently, almost any portion of the organ may be affected, from the fundus to the pylorus. Ulcerations may be present but the most obvious feature in these cases is the rounded masses. They may be multiple, as in our case, or they may be large and solitary, as reported by Browne and McHardy (1).

The history and physical findings are of little value for the diagnosis. The ordinary laboratory procedures are of no help. The blood counts may be of any type. The disease is limited entirely to the stomach, with no evidence of chest pathology or of lymphadenopathy elsewhere in the body. Palpable masses are not always found, and the history may be rather acute in onset or it may extend over a period of many years. In the authors' case, the gastric symptoms began some two months before admission, although the patient had had vague complaints for many years, putting him in the classification of a psychoneurotic. Pain may or may not be present. Frequently it is of the ulcer type. Obstructive symptoms may occur if the lesion is near the pylorus or possibly adjacent to the esophageal opening. Weight loss may vary from none at all up to that suggesting carcinoma. Gastroscopic examination is not of value; in fact, it has probably been a detriment so far as further treatment of these patients is concerned, as most examinations of this type, as reported in the literature, have tended to confirm the x-ray diagnosis of extensive carcinoma and thereby to preclude further diagnostic procedures.

The only relatively constant finding, as seen in the present case and in any of the others reported—and it is not seen in all—is the presence of polypoid-like

[1] Accepted for publication in December 1947.

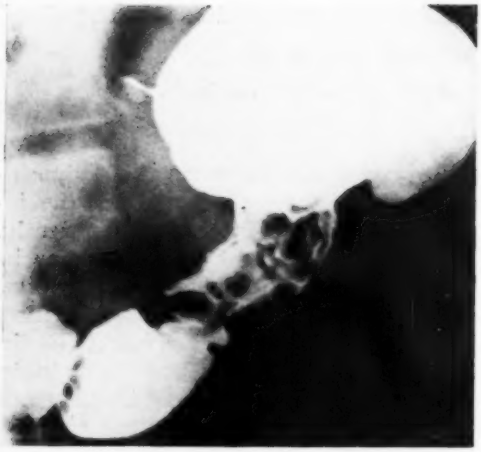

Fig. 1. Radiograph of the stomach showing extensive involvement of the body of the stomach, revealing extensive, rather characteristic polypoid and hemispherical defects with ulceration.

growths along the region of the infiltrated gastric wall.

## CASE REPORT

J. S., white male, age 60, was admitted to the Psychiatric Service of the Louisville General Hospital on July 3, 1947, complaining of nervousness and inability to sleep. For the two months prior to admission he had experienced abdominal discomfort consisting of rather sharp and constant pain in the epigastrium. The pain was not radiating in character and nothing in particular seemed to relieve it. The patient had vomited occasionally and there had been diarrhea at times. No evidence of blood was seen in the vomitus. There had been a loss of approximately 30 pounds of weight in the last two months.

The patient gave a history of alcoholism for many years and of treatment at another institution, immediately before this admission, for psychoneurosis—anxiety state. He had been given insulin and picrotoxin shots while there. Earlier he had received eight electric shock treatments. Except for the chronic alcoholism, the past history was not remarkable. The only surgical procedure had been a cholecystectomy about a year and a half previous to the present admission.

Physical examination revealed nothing particularly unusual. The patient was thin but rather well developed. No abdominal mass was felt. The blood pressure was 118/82. No nodes were palpable anywhere in the body. Laboratory findings showed spinal fluid cell count 0; globulin negative; sugar 82 mg. per 100 c.c.; chlorides 726 mg. per 100 c.c.; total protein 31 mg. per 100 c.c.; colloidal gold curve negative. The urine was clear, yellow, acid, with a specific gravity of 1.020, negative for sugar and albumin. Microscopically it showed 3 to 4 white cells and 1 to 2 red blood cells per high-power field. Both the spinal and blood Kahn reactions were negative. The blood count was as follows: red cells 3,700,000; hemoglobin 11 gm.; white cells 8,300 (polymorphonuclears 87 per cent; lymphocytes 12 per cent; monocytes 1 per cent). The electrocardiographic tracing showed a rate of 88, rhythm regular, slurring of the QRS complex in Leads I, II, and III. Serum amylase was 118 mg. per 100 c.c. The specific gravity of the blood (copper sulfate method) was 1.0475; of the plasma 1.022. Gastric analysis was not done.

While on the Psychiatric Service, the patient continued to receive insulin and picrotoxin shots. However, in view of his history of recent weight loss plus the fact that he continued to lose weight under the insulin therapy, it was the opinion of the psychiatric staff that gastro-intestinal examination should be obtained.

*Radiologic Findings:* Gastro-intestinal studies revealed marked narrowing of the gastric lumen (Fig. 1) involving the entire body of the stomach, with much irregularity of outline and rigidity in that area. The involvement appeared to extend from several centimeters below the esophageal opening distally as far as the incisura angularis. No definite mass was felt during the examination. Numerous hemispherical filling defects were present along the body of the stomach, with a suggestive ulcer in the area of involvement and also in the distal portion. The radiographic diagnosis was extensive infiltrating, scirrhous carcinoma of the stomach. A gastroscopic examination was not obtained.

The patient refused operation at this hospital and was transferred to a private institution, where a total gastrectomy was performed by Dr. R. Arnold Griswold, Head of the Department of Surgery, of the University of Louisville School of Medicine, who will report elsewhere the surgical management of cases of this type.

*Pathological Report:* The gross specimen (Fig. 2), consisting of the stomach along with a portion of the omentum, reveals the extent of the process, with marked infiltration of the walls of the stomach, loss of the gastric rugal pattern, with some pocketing, and the polyp-like formation seen on the radiograph. There was also noted some ulcer formation in the distal portion. Along the external surface of the lesser curvature were three grayish-pink, firm, dimpled structures which appeared to be an extension of the malignant process from the mucosal surface. The largest was near the fundic end of the stomach, measuring approximately 6 × 5 cm. in diameter. The other two measured 2.5 × 3.0 and 1.5 × 2.5 cm. in diameter, respectively. On opening the stomach along the greater curvature, the mucosal surface was easily visualized. There were several ulcerative malignant areas producing

marked thickening of the wall. The largest ulcer measured 8.5 × 4.5 × 2 cm. On cutting through the neoplastic process, it was observed that the muscularis was grayish white and quite fibrotic. The other ulcerative areas had a similar appearance. One enlarged lymph node was observed along the upper portion of the greater curvature, measuring 1.5 × 1.0 cm. in diameter. On cut section it was not remarkable.

The spleen weighed 160 gm. and was friable and congested. On cut section the malpighian bodies were quite indistinct. It appeared as if the spleen were markedly congested by an excessive amount of blood.

Fig. 2. Pathological specimen showing marked induration of the gastric wall by the infiltrative process, with disruption of the rugal pattern and polyp-like formation.

Microscopic examination of the stomach (Fig. 3) showed complete necrosis of the mucosal surface, with extension and infiltration of pleomorphic cells into all layers of the wall. The characteristic typical cell was large, with a distinctly eosinophilic cytoplasm containing 1 to 3 nuclei which were vesicular in character and frequently indented. These nuclei also contained nucleoli. The lymphoid tissue and mucosa and muscularis of the entire stomach wall were replaced by this diffuse infiltration of giant cells, plasma cells, eosinophils, lymphocytes, and occasional polymorphonuclear neutrophils. There were also areas of fibrosis with interlacing bands of fibroblasts but relatively little necrosis. Sections of the lymph node showed the normal lymphoid architecture maintained in most areas, but with a diffuse infiltration of Dorothy Reed cells throughout. These Dorothy Reed cells are of the same type as those described in the stomach as pleomorphic giant cells. In the section of the esophagus adjoining the stomach, there was necrosis of the esophageal wall with destruction of the muscular architecture and infiltration of Dorothy Reed cells beneath the stratified squamous epithelium, which in some areas showed some hyperkeratosis.

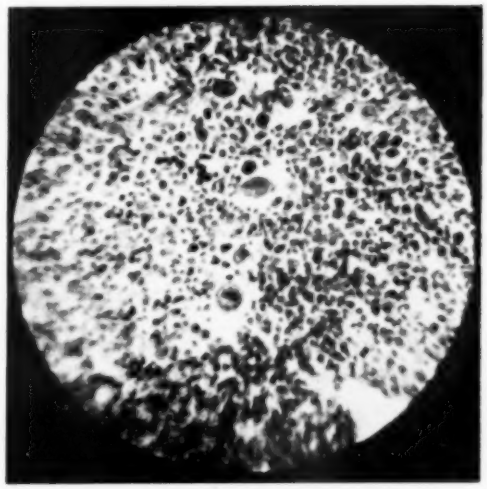

Fig. 3. Photomicrograph of a section of the stomach, revealing three characteristic large Dorothy Reed cells, along with plasma cells, eosinophils, lymphocytes, and polymorphonuclear neutrophils.

*Microscopic Diagnosis:* (1) Hodgkin's disease of the stomach with extension into the esophagus and perigastric lymph nodes. (2) Marked splenic congestion but no evidence of Hodgkin's disease in the spleen.

The patient died on the sixth postoperative day. Autopsy revealed no evidence of Hodgkin's disease elsewhere in the body.

## SUMMARY

Primary Hodgkin's disease of the stomach is rarely diagnosed. Twenty-two cases have been recorded in the literature, and a twenty-third is here reported. The roentgen diagnosis in this case was infiltrating scirrhous carcinoma. Operation revealed Hodgkin's disease of the stomach with extension into the esophagus and perigastric lymph nodes.

It is believed that many cases of Hodgkin's disease of the stomach are diagnosed radiologically as extensive infiltrating carcinoma and that in the absence of operation and autopsy the true condition remains undiscovered. The radiologist should bear this possibility in mind, especially in view of the relatively high proportion of operative cures. The principal diagnostic criterion is the presence of polypoid-like masses along the course of the involved area of the stomach.

NOTE: The authors wish to express their appreciation to Dr. William R. Platt, Pathologist, and the Staff of the Norton Memorial Infirmary, Louisville, Ky., for their co-operation in making their operative material available.

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## SUMARIO

### Diagnóstico de la Enfermedad de Hodgkin Primaria del Estómago

La enfermedad de Hodgkin primaria del estómago es rara vez diagnosticada. En la literatura constan 22 casos, y el vigésimotercero es ahora descrito. El diagnóstico roentgenológico en este caso había sido carcinoma escirroso infiltrante. La operación reveló enfermedad de Hodgkin del estómago con difusión al esófago y a los ganglios linfáticos perigástricos. Parece que muchos casos de enfermedad de Hodgkin del estómago son diagnosticados radiológicamente como carcinoma infiltrante extenso y que, de no hacerse una operación o la autopsia, queda sin descubrir el verdadero estado.

El radiólogo debe tener presente la posibilidad de enfermedad de Hodgkin del estómago, máxime dada la proporción relativamente alta de curaciones quirúrgicas. La principal pauta de diagnóstico consiste en la presencia de masas polipoideas en el trayecto de la zona afectada.

# Primary Malignant Heart Tumor Diagnosed in Vivo With the Aid of Artificial Pneumopericardium[1]

KAREN LÜBSCHITZ, ERLING LUNDSTEEN, and EVA FORCHHAMMER

Maribo, Denmark

WHILE A CONSIDERABLE number of tumors of the heart have been reported in the literature, they are still relatively infrequent. Most of them have been necropsy findings, but more recently an increasing number have been diagnosed *in vivo*. To the purely academic satisfaction of arriving at a correct diagnosis even in cases bound to have a fatal issue, there is now added a more practical consideration. In recent years, certain cases of heart tumor have been treated with temporary or lasting effect, thus further inciting one to establish the diagnosis in good time. As a contribution to efforts in that direction we report the following case, in which, though the clinical picture had already suggested the presence of tumor, it was nevertheless the induction of pneumopericardium, in connection with roentgen examination, and the demonstration of tumor cells in the pericardial exudate, which clinched the diagnosis.

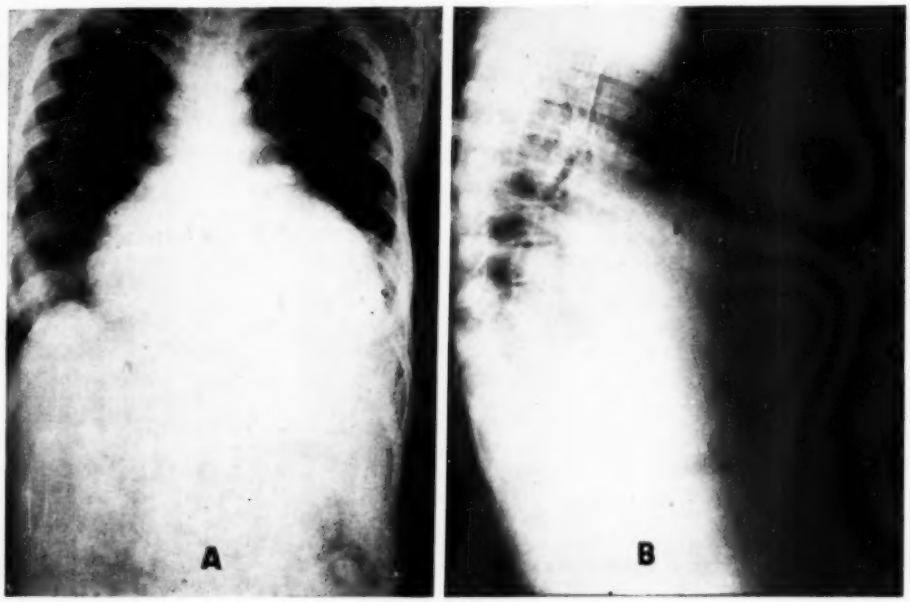


Fig. 1. A. Roentgenogram of the heart taken before puncture of the pericardium was done. It shows the considerable enlargement, and its uncharacteristic form. B. Lateral view of the greatly enlarged heart shadow.

## CASE REPORT

The patient was an unmarried woman, 23 years old, who was admitted to the Maribo Hospital, Sept. 22, 1944, complaining of palpitation but with no other symptoms. Her health during childhood and adolescence had been good. Physical examination showed nothing abnormal. The possibility of Graves' disease was considered, but the metabolism was normal, as were the roentgen findings and the electrocardiogram. The Wassermann test was negative. A diagnosis of neurasthenia was made and the patient was discharged on Oct. 10.

She continued to suffer from palpitation, which,

[1] From the Town and County Hospital, Maribo, Denmark (Chief: Erling Lundsteen, M.D.). Accepted for publication in December 1947.

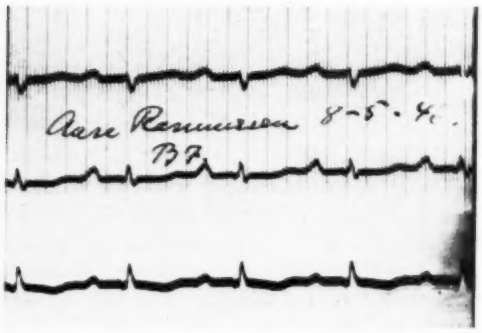

Fig. 2. Electrocardiogram showing the prolonged conduction time, right axis shift, and inverted T in Lead III.

however, did not prevent her from continuing to work as usual until November 1945, when she began to experience pain in the left side of the chest, accompanied by cough, expectoration, and fever. These symptoms regressed in the course of a few weeks, but shortly afterward nausea and vomiting occurred, with pressing pain in the epigastrium. Hepatic disease was suspected, and the patient was readmitted to the hospital Jan. 15, 1946.

At the hospital the abdominal symptoms were from the beginning the object of attention. Liver function tests, however, showed normal conditions. Laboratory findings were as follows: hemoglobin 102 per cent; sedimentation rate 3 mm./hr.; blood pressure 120/100; antistreptolysin titer 32; Mantoux I negative; Mantoux III positive; icterus index 8; no albumin, sugar or urobilinogen in the urine. No precise extension of the heart borders could be made out. The heart beat could not be felt. The heart sounds were distant but clear, without accentuation; the action was regular, about 80.

Roentgen examination of the stomach (Jan. 28) showed nothing abnormal except that the distance of the fundus from the diaphragm was unusually great. The silhouette of the liver appeared to be enlarged. A chest examination showed both relative and absolute enlargement of the heart (length 18 cm., breadth 18 cm.; transverse diameter of thorax 26.5 cm.), with evidence of slight exudate in the left pleura but no congestion in the lungs (Fig. 1).

Electrocardiography (Fig. 2) showed all complexes low (less than 5 mm.), slightly prolonged conduction time (0.23 second), and right axis shift with inversion of T in Lead III.

The temperature was normal at admission, but gradually rose to around 39° C. During the later course of the disease it was at times elevated, at other times normal. The heart rate increased to about 100, edema developed in the loins and the lower extremities, and ascites, enlargement of the liver, albuminuria (9 per mille), and slight diuresis were observed. The case was judged to be one of pericarditis and pleurisy of tuberculous nature, although the tuberculin test (Mantoux) was positive only in the highest concentration and not in dilution.

The patient was treated with digitalis, strophanthone, and mersalyl and was put on a diet deficient in salt and water, but the effect on the symptoms of cardiac insufficiency was slight and transitory.

Roentgenographically the heart appeared still larger and two small shadows were demonstrable in the lungs, suspected to be due to infiltration. For a while, also, strong pleural friction sounds were heard over the left anterior chest.

The patient's condition grew gradually worse: cyanosis increased, the heart rate rose to 120, the radial pulse became small, and there was marked stasis in the veins of the neck; the veins on the back of the hand did not collapse until about 30 to 40 cm. above the level of the heart. The liver increased in size until it extended almost to the umbilicus, and jaundice was pronounced (icterus index 40).

On April 4, a pericardial puncture was done to ease the patient, and 630 c.c. of sanguinolent fluid were evacuated. The fact that the exudate was tinged with blood, together with the rather unusual clinical picture, led to the first suspicion of a possible tumor, but as hemorrhagic effusion may be found also in association with tuberculous pericarditis, the finding was, of course, not decisive. Repeated microscopy and cultivation of the pericardial fluid after each of four punctures failed, however, to show tubercle bacilli. The fluid reaccumulated in a rather short time and, although the patient experienced some relief after the first puncture, repetition of the procedure was without similar effect. Roentgen examination after the punctures showed the heart shadow diminished, but there were no visible tumor shadows.

On May 28, after evacuation of 960 c.c. of fluid, 400 c.c. of air were introduced and a roentgen examination was made immediately afterwards (Fig. 3). The heart was seen very distinctly, surrounded by air distributed rather evenly in the pericardium. The heart was not enlarged, or only slightly so, but intrapericardially, on the right side, in the lateral view anteriorly, was a soft-tissue shadow measuring about 7 × 3 cm. Also visible in the lateral view were several roundish shadows about the size of a cherry. As all these contrasted clearly with the very thin pericardial shadow, the consensus of opinion was that they did not represent an inflammatory process but rather neoplastic formations. This view was confirmed shortly afterwards by the microscopic demonstration of tumor cells in the pericardial fluid (rather dark, mononuclear cells with relatively large atypical nuclei and scant cytoplasm).

*Necropsy:* On June 19, 1946, the patient died. Necropsy showed a heart measuring 10.5 × 8 cm., 23 cm. in circumference, and of fully medium fat-

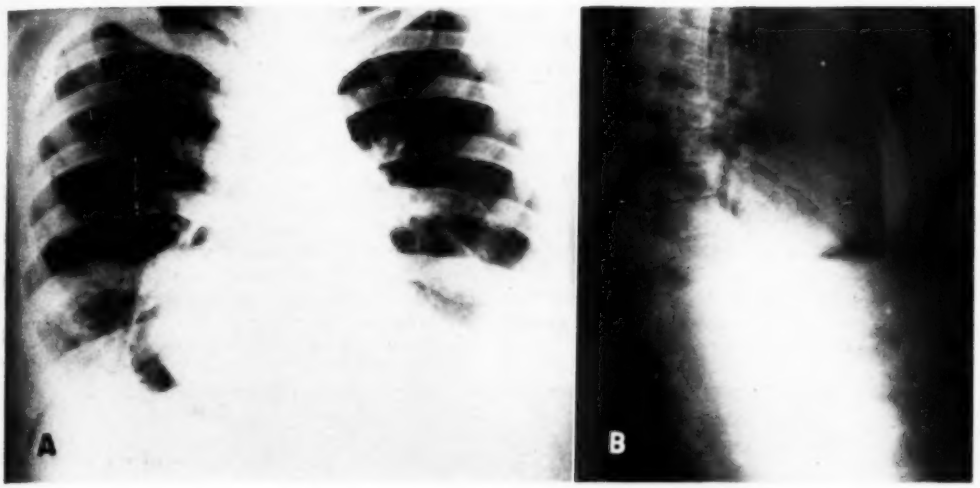


Fig. 3. A. Roentgenogram of the heart after evacuation of the pericardial exudate and induction of artificial pneumopericardium. A distinct tumor shadow is seen, corresponding to the right atrium. B. Lateral view of the heart after induction of pneumopericardium. The tumor shadows are seen anteriorly.

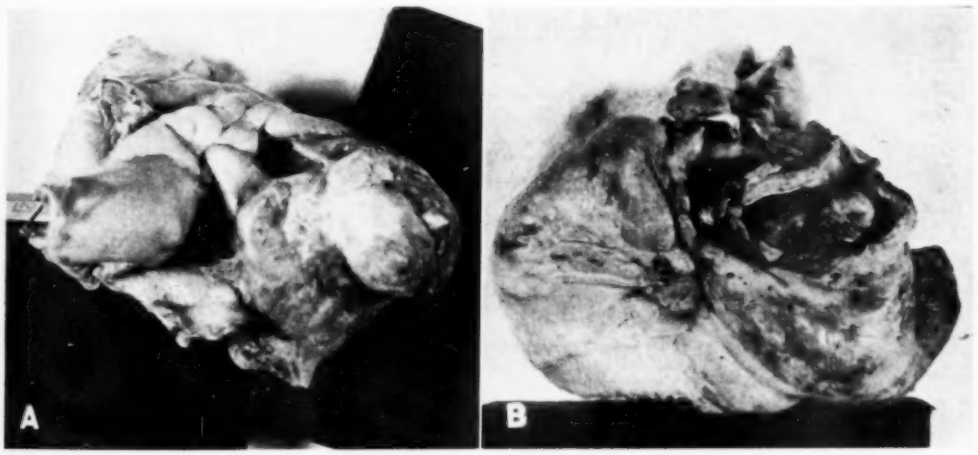


Fig. 4. A. The heart seen from above, the aorta to the right, the tumor to the left. B. Posterior view of the heart. The tumor is seen in the right atrium, which has been opened.

ness. Anteriorly, at the level of the orifice of the pulmonary artery, was an area of sundered adhesions, measuring barely 1 cm. Otherwise the pericardium was smoothly shining, pellucid. The outer aspect of the heart was somewhat deformed by a knobby protuberance on its right side, at the level of the atrium, consisting of a dark tumor speckled with gray, fully twice as large as a hen's egg (Fig. 4). The tumor had distended the atrium and seemed in two places, corresponding, respectively, to the upper and middle part of the right border, to extend out through the pericardium, in the former site by direct invasion, in the latter by metastasis. The surface at these points was darkly granular. On opening the heart, the tumor, with its knobby and in part polypous surface, was seen to fill the right atrium almost completely. It seemed to arise from a portion of the lateral wall about 5 cm. long, whence it bulged into the cavity and extended to the orifices of both venae cavae, leaving only a narrow space free between its surface and the interauricular septum. A tongue-shaped projection the size of a walnut reached down into the ostium of the tricuspid valve, to which it was partially adherent, and extended for a distance of about 1.5 cm. into the upper part of the right ventricle. The wall of the latter was 3 mm. in thickness and the wall of the left ventricle 8 mm. There

were no acute or chronic changes in the valves, no fibrosis and no calcification. The foramen ovale was closed. There were no parietal thrombi, nor any scattered nodules in the myocardium. The tumor was firm, with a marbled appearance, for the most part grayish-brown with darker specks and islands of yellowish, necrotic tissue. The vascular trunks were normal. The heart weighed 295 gm.

The other organs revealed no abnormalities except chronic pleurisy, and signs of congestion and remnants of infarcts in the lungs. There were no metastases.

*Microscopically* (Fig. 5), the tumor tissue was found to be composed of numerous close-set cells of barely medium size, some fusiform and others sharply circumscribed necrosis, exudation of fibrin, and beginning calcification.

In sections from the base of the tumor, lively infiltration of the wall of the atrium was seen. The hemangiocavernous character was here somewhat more pronounced; in some places the tumor tissue extended all the way out to the endothelium-lined surface. Distal to this area, beneath the endocardium, were a scattered stronger accumulation of blood pigment, fresh hemorrhage, and round-cell infiltration; on the serosa were moderately thick deposits, or tufts, of fibrin, which neither had undergone distinct autolysis nor were the seat of incipient organization. In a few of these tufts were small groups of elements resembling tumor cells.

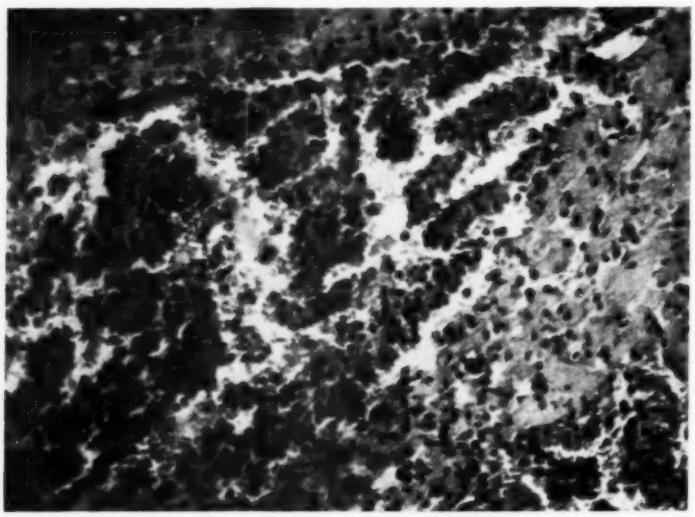

**Fig. 5. Photomicrograph of the tumor showing numerous closely set tumor cells with medium-sized nuclei and homogeneous cytoplasm. The cells are arranged partly in broad streaks, partly surrounding irregularly shaped, branching, blood-filled cavities.**

roundish-cuboid. Their nuclei were round or oval in shape, with abundant or fairly abundant chromatin; mitotic figures were rather infrequent. The cytoplasm, which formed a moderately broad or narrower zone, was homogeneous and weakly stainable. There were no multinuclear cells or giant cells. In some places, the tumor cells formed dense, homogeneous, sarcoma-like areas poor in stroma; in others they formed the lining of smaller and larger vessels or of moderately large or larger, irregularly shaped, branching blood-filled cavities, partly of papillomatous or cavernous character. Through the tumor tissue there extended a number of rather large, thick, partly hyalinized septum-like streaks of connective tissue poor in cells. Some of the blood-filled cavities were thrombosed and the seat of incipient organization. On the surface of the tumor were blood and fibrin. Some parts showed rather

*Histologic Diagnosis* (Svend Petri, M.D.): Hemangio-endotheliosarcoma of the right atrium, with involvement of the visceral pericardium.

## DISCUSSION

We have here the case of a young woman, 23 years old, with symptoms of severe cardiac insufficiency with edema, enlargement of the liver, and pleural exudate. Roentgen examination showed considerable enlargement of the heart shadow. Adequate treatment had very little effect on the cardiac insufficiency, even after considerable quantities of pericardial fluid had been evacuated. The fluid was sanguinolent

and was found to contain tumor cells, and roentgen examination after the induction of artificial pneumopericardium showed the presence of a tumor shadow. The patient died, and necropsy revealed a growth (hemangio-endotheliosarcoma) which, arising from the right atrium, filled the latter, sending an extension down through the ostium of the tricuspid valve into the right ventricle and, growing through the atrial wall, invaded the visceral pericardium.

It was thought at first that the patient might be suffering from tuberculosis of the lung and pleura. This diagnosis was suggested by the course of the temperature curve, the normal antistreptolysin titer, the pleural friction sounds, and the circumstance that she had been exposed to tuberculous infection. Furthermore, the electrocardiogram was quite consistent with a pericarditis, and the hemorrhagic pericardial fluid was no indication to the contrary. On the other hand, it appeared strange that the exudate continued to reproduce itself, and that the venous stasis and pressure did not diminish after the evacuation of nearly 1,000 c.c. of pericardial fluid. The cardiac insufficiency could not, therefore, be due to cardiac tamponade. Moreover, the sedimentation rate in the beginning, before fever set in, was only 3 mm./hr., despite the copious exudate in the pericardium, and, finally, the positive Mantoux III and negative Mantoux I did not seem entirely consistent with an active tuberculous process. This suggested the possibility of a cardiac tumor with large exudate in the pericardium and resulting cardiac insufficiency and infarcts in the lung. Confirmation of this diagnosis was obtained by means of roentgen studies following artificial pneumopericardium and the finding of tumor cells in the pericardial exudate. The prolonged conduction time demonstrated electrocardiographically is explained by the fact that the tumor was situated in the right ventricle.

As stated above, tumors of the heart are comparatively rare. This is true of both primary and metastatic neoplasms, but especially of the former. Figures based on necropsy material vary considerably. Lymburner (1934), for example, found among 8,550 necropsies 4 primary (0.05 per cent) and 52 metastatic (0.6 per cent) tumors of the heart. In 1,200 necropsies Shelburne encountered 3 primary (0.25 per cent) but no metastatic tumors. Scott and Garvin (1939), on the other hand, in 11,000 necropsies found no primary cardiac tumors but 118 metastatic growths (10.9 per cent). Straus and Merliss' (1945) figure for primary tumors is 3, or 0.19 per cent; they found no secondary tumors.

Probably more nearly correct than the figures based on these smaller series are those of the American Medical Association, cited by Straus and Merliss. According to these, among 480,331 necropsies performed in the United States from 1938 to 1942 there were only 8 cases of primary cardiac tumor, an incidence of 0.0017 per cent.

A review of the literature by Straus and Merliss revealed 163 primary cardiac tumors reported up to 1945. In only a few of these had the diagnosis been made *in vivo*. In 1942, Doane and Pressman estimated that altogether 20 cases of tumor of the heart—primary and metastatic—had been diagnosed before death (the first by Roesler in 1924). Only 4 of these were primary tumors:

(1) A spindle-cell sarcoma reported by Zemansky in 1928, diagnosed by the demonstration of tumor cells in the pericardium.

(2) A cardiac rhabdomyosarcoma reported by Barnes, Beaver, and Snell in 1934, in which the diagnosis was based on the clinical symptoms together with the finding of metastases in the shoulder girdle. There were no roentgenologic changes.

(3) A sarcoma of the heart diagnosed by Shelburne in 1934. The patient, a man 24 years old, became ill with rapidly increasing signs of cardiac decompensation and partial heart block, and a considerable serosanguineous pericardial effusion. As Shelburne believed that simple or tuberculous pericarditis as well as gumma could be excluded, he made a diagnosis of tumor.

(4) A sarcoma described by Popp in 1937, in a man 33 years old. The roentgenologic picture, which showed localized, rapidly increasing enlargement of the heart shadow corresponding to the right atrium, was the principal guide to the diagnosis.

Eight other cases have been reported in which primary tumor of the heart or pericardium was diagnosed before death.

(5) Beck and Thatcher (1925) made a diagnosis of cardiac tumor in a man 27 years old with a sarcoma arising from the left atrium. The diagnosis was based on the presence of a murmur, low blood pressure, and the roentgenologic demonstration of deformity of the cardiac silhouette corresponding to the left atrium.

(6) Andolf, Bergmark and Gellerstedt (1937) diagnosed epicardiac celothelioma in a man 27 years old with a mediastinal tumor and pericardial exudate containing tumor cells.

(7) Jucker (1941) reported a case of hemangioendothelial sarcoma arising from the pericardium. The diagnosis was based chiefly on the roentgenologic picture, which in the course of a year showed change from a normal to a greatly enlarged heart shadow. Kymography showed absence of pulsation on the right side. As no primary tumor could be demonstrated outside the heart, Jucker concluded that the latter must be the seat of a primary neoplasm. There was no pericardial effusion.

(8 and 9) Beck (1942) reported 2 cases of benign intrapericardial tumor diagnosed *in vivo*. In both cases the roentgenologic picture helped essentially to establish the diagnosis, inasmuch as there was a directly visible tumor shadow, in one case on the right side and in the other on the left.

(10) Ravid and Sachs (1943) diagnosed a primary polypoid fibromyxosarcoma of the left atrium on the basis of the clinical picture, which showed periodic signs of cardiac decompensation and "ball-and-valve" symptoms, *i.e.*, collapse in certain positions favoring obstruction of the mitral orifice by the tumor.

(11) In the same year, Gebauer diagnosed a cardiac tumor in a girl, 12 years old, with an intrapericardial teratoma. The patient suffered from marked dyspnea, and Gebauer demonstrated a considerably enlarged heart shadow which, after induction of artificial pneumopericardium, proved to contain a normal cardiac silhouette and a tumor shadow anterior to the heart.

(12) Also in the same year, Hansson and Söderström diagnosed a case of pericardial tumor (celothelioma) on the basis of its clinical and electrocardiographic symptoms, and by venography of the upper extremities, as the roentgenograms did not show anything abnormal corresponding to the heart shadow.

The symptoms in cases of heart tumor are frequently signs of cardiac decompensation developing without demonstrable cause and absolutely refractory to treatment. Sometimes the stasis is related particularly to the region of the superior vena cava, in cases of atrial or pericardial tumor involving the latter; and often cyanosis is more pronounced and progressive than the other symptoms. In the case of peduncular intracardiac tumors that in certain positions of the body obstruct the orifices, there may periodically be marked signs of cardiac insufficiency. Very often, probably in most cases, there will be arrhythmia, often complete atrioventricular block due to the tumor involving the system of conduction. A pericardial exudate is found in only about half of the cases in which the pericardium is the primary site of a tumor or is involved by an actual cardiac neoplasm. The exudate is practically always sanguinolent, but this is no proof of the existence of a tumor, since hemorrhagic effusion may be found also in tuberculous pericarditis, leukoses, and other diseases. If there is a tumor, the pericardial exudate will probably in many cases contain tumor cells, but this has been determined in comparatively few instances.

The electrocardiographic changes depend entirely on the location of the lesion. Electrocardiograms have been described showing cardiac infarction, branch block, sinoauricular and atrioventricular block, Stokes-Adams syndrome, tachycardia, and arrhythmia, as, for instance, atrial flutter. Often after a short time there will be a typical development of the electrocardiographic picture. In other cases the electrocardiograms may be normal. If there is pericardial exudate, there may, as in other forms of pericarditis, be changes, with low voltage, as in our case, where there were also signs of right axis shift and inverted T waves.

Finally, the roentgen examination may often reveal characteristic signs, but it should be remembered that a cardiac tumor may be present even if the roentgenologic picture is normal. Often there will be more or less characteristic changes in the heart shadow. Sometimes there may even be a distinct tumor shadow, as in the two cases reported by Beck in 1942, in which such shadows were the means of establishing the diagnosis beyond doubt. In other cases,

an intracardiac tumor may cause considerable dilatation of some particular part of the heart, as in the case reported by Bennett, Konigsberg, and Dublin in 1938. Or there may be a localized increase due to tumor infiltration in some part of the myocardium, in which case diminished or suspended pulsation in the area in question, as pointed out in 1937 by Popp and by Doane and Solis-Cohen, may suggest the presence of a tumor.

The enlargement of the heart shadow, though often considerable, is in most cases uncharacteristic. But a rapidly increasing enlargement should always make one consider the possibility of a neoplasm. If it then proves to be due to exudate in the pericardium, the induction of artificial pneumopericardium may, as in our case, give valuable information. The possibility of using this procedure as an aid to diagnosis is mentioned in Schinz, Baensch, and Friedl's "Lehrbuch der Röntgendiagnostik," but we have found it used thus in only one case, namely that reported by Gebauer, cited above, where it served in a case of intrapericardial teratoma in a twelve-year old girl to bring out the tumor shadow in the roentgenogram.

The prognosis in cardiac tumors is as a rule bad. Even with benign tumors, the symptoms often rather early become threatening. There are, however, cases on record in which symptoms of intracardial myxoma were present for many years, as in the example reported by Strouse in 1938, where the duration of the disease was forty-three years. There are several reports, also, of the incidental finding, at necropsy, of benign tumors of the heart which had been completely, or almost completely, silent clinically. Such cases have been reported by Arnesen (1925) and by Guldberg (1928). In both these cases, the tumor was a fibroma in the atrium. Malignant cardiac tumors, on the other hand, run a comparatively brief course, and the issue is invariably fatal.

Formerly there were no possibilities of dealing effectively with tumors of the heart, but in recent years attempts both with roentgenologic and operative treatment have been more encouraging. Popp, for instance, reported in 1937 a case of sarcoma of the right atrium in which the symptoms improved after a roentgenologic treatment instituted only for purposes of diagnosis. In 1940 Shelburne and Aronson described a case of metastatic myeloblastoma expressing itself in heart block and pericardial exudate containing tumor cells, in which, following roentgen treatment, the roentgenologic picture returned to normal, the electrocardiogram changed in the course of a month to indicate only partial block and finally became normal, and the patient was for some months symptom-free and capable of working, until metastases developed in other organs. A report from China, by Hsiung, Szutu, Hsieh and Lien (1940) also shows the good effect, both subjectively and objectively, of roentgen treatment on a metastatic cardiac tumor (from a reticulosarcoma of the nose), the roentgen picture, which had shown an enlarged heart shadow with kymographic signs of exudate, becoming normal following the treatment.

Attempts to remove cardiac tumors operatively have also been made in recent years. In the case described by Gebauer, extirpation was done in three stages, but, owing to its close adhesion to the aorta, the tumor burst and the patient died. Beck, in his two cases of benign tumor mentioned above, operated successfully. One of his patients, a twenty-two-year old man with an intrapericardial teratoma, had been symptom-free and capable of working for four years, and the roentgenologic picture had remained normal. The other patient, a man aged thirty-nine, had a benign tumor of cystic character situated intrapericardially, close to the left atrium, with symptoms resembling those of coronary sclerosis. Following removal of the tumor he had been symptom-free, with a normal roentgenogram, for eighteen months.

These results, of both roentgenologic and surgical treatment, must stimulate us not only to establish an early diagnosis but also to institute adequate therapy, since in

many cases it will unquestionably be possible to alleviate the condition by means of roentgen irradiation. The cases in which operative treatment will be of any avail are undoubtedly few, as, indeed are the cases in which there is any chance of initiating such treatment. Nevertheless, it is worth mentioning in this connection that Beck suggests the possibility of operating in cases not only of extracardial, but also of intracardial tumor by leading the circulation to the cerebrum around the heart during the operation; a perspective which will be of interest particularly in cases of pedunculated myxoma in the atria with a tendency to obliterate the ostia.

## SUMMARY

A case of hemangio-endotheliosarcoma of the right atrium, in a woman twenty-three years old, was diagnosed *in vivo* on the basis of the clinical symptoms (sudden manifestation of severe cardiac insufficiency refractory to treatment), a profuse sanguinolent exudate in the pericardium containing tumor cells, and roentgenologic demonstration of tumor shadow following induction of artificial pneumopericardium. This adds a thirteenth case to the 12 previously recorded in the literature of primary tumor of the heart diagnosed prior to death. On the basis of the literature, the authors point out that therapy, either roentgenologic or surgical, may be utilized with advantage in certain cases of cardiac tumor. In view of this, early diagnosis becomes a matter of practical importance.

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SUMARIO

**Tumor Cardíaco Maligno Primario Diagnosticado in Vivo con la Ayuda del Neumoperitoneo Artificial**

Este caso de hemangioendoteliosarcoma de la aurícula derecha en una mujer de 23 años de edad fué diagnosticado *in vivo* a base de los síntomas clínicos (súbita manifestación de intensa insuficiencia cardíaca refractaria al tratamiento), profuso exudado sanguinolento en el pericardio que contenía células neoplásicas, y a continuación de la inducción del neumoperitoneo artificial, hallazgo radiológico de sombra de tumor. Este caso agrega el décimotercero a los 12 casos que constan en la literatura, de tumor primario del corazón diagnosticado antes de la muerte. A base de la literatura, la terapéutica, ya roentgenológica o quirúrgica, puede utilizarse con provecho en algunos de estos casos, por lo cual el diagnóstico temprano reviste importancia práctica.

# Spontaneous Pneumothorax Associated with Metastatic Sarcoma

## A Report of Three Cases[1]

LT. COL. ELMER A. LODMELL, M.C., U.S.A.,[2] AND CAPT. SAMUEL C. CAPPS, M.C., A.U.S.[3]

SPONTANEOUS pneumothorax and interstitial emphysema have long been recognized in a variety of pathological conditions. Sarcomatous and carcinomatous pulmonary metastases are also common findings, yet the association of spontaneous pneumothorax with metastatic tumors in the lung is apparently a rare condition. So far as we know, the only cases recently studied were reported by Thornton and Bigelow (1) in 1944.

The two cases reported by Thornton and Bigelow occurred in young males. In one case massive pneumothorax developed approximately five months following amputation of the forearm for a fibrosarcoma of the hand. In the other case the pneumothorax occurred approximately five months following disarticulation of the hip for an osteogenic sarcoma in the left femur. It was the opinion of the writers that necrosis of the metastatic tumors played an important part in the production of bronchopleural fistulae and pneumothorax.

Observation of three cases of spontaneous pneumothorax associated with metastatic sarcoma in Percy Jones General Hospital within a relatively short period is considered to be of sufficient interest to warrant a detailed report. In many respects the cases here described are similar to those reported by Thornton and Bigelow. All the patients were young males; one had a fibrosarcoma primary in the neck, another an osteogenic sarcoma primary in the tibia, and the third an angiosarcoma primary in the retroperitoneal space. In all cases the extensive pulmonary metastases were recognized early in the course of the disease, and in each instance pneumothorax was known to exist for a period of weeks prior to death.

CASE I: White male, age 18. On Oct. 25, 1946, a right mid-thigh amputation was done for osteogenic sarcoma of the tibia. Examination of the specimen revealed invasion of the blood vessels of the lower thigh by tumor cells.

The immediate postoperative course was uneventful. On Nov. 10, 1946, the patient experienced sharp chest pain, and a roentgenogram made at that time revealed a bilateral pneumothorax and several small metastatic tumor nodules in both lung fields. Several attempts were made to relieve the pneumothorax by thoracentesis, but following each withdrawal the pleural space refilled with air almost immediately (Fig. 1). In spite of the persistence of the pneumothorax, the patient's general condition remained good and, since he had been provided with a prosthesis, he regularly attended reconditioning and walking classes. He made rapid progress in the use of his prosthesis and continued ambulatory until Jan. 15, 1947, when he experienced an acute attack of dyspnea. From that date he failed rapidly and died on Feb. 7, 1947. The roentgenogram made just prior to his death showed a marked increase in the degree of pneumothorax and in the number and size of metastatic tumor nodules in both lungs (Fig. 2).

*Necropsy:* The body was well developed and nourished. The right leg had been amputated through the mid thigh and there was no local residual tumor. Air escaped on opening the thoracic cavity under water. There were no pleural adhesions, but each pleural cavity contained 500 c.c. of thin bloody fluid. The diaphragm was depressed to the level of the tenth rib bilaterally.

The lungs together weighed 1,780 gm. Each was collapsed and airless, distorted, and lobulated by massive tumor involvement. The visceral pleura was ballooned irregularly from the underlying lung tissue by subpleural collections of air, forming thin-walled sacs measuring up to 20 cm. in circumference. Several subpleural pockets were filled with thin sanguineous fluid. In several areas necrotic tumor had eroded through the pleura from parenchymatous nodules. Necrosis, hemorrhage, cystic degeneration, and calcification were common in the tumor nodules The intervening tissue showed edema and atelectasis. There was acute dilatation of the right heart.

Microscopic examination showed many tumor nodules of all sizes throughout the lung tissue.

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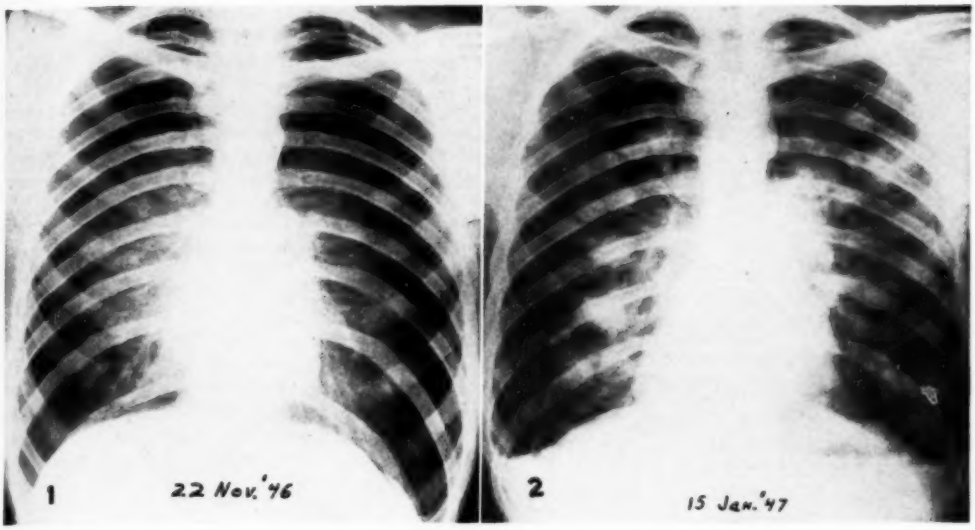


Figs. 1 and 2. Case I. Fig. 1 (twenty-eighth postoperative day) shows bilateral pneumothorax and numerous poorly defined metastatic nodules. Fig. 2 (eighty-second postoperative day, twenty-three days before death) shows persistence of the pneumothorax and increase in number and size of the metastases.

Between these were areas of intra-alveolar hemorrhage and numerous vacuolated and pigment-containing macrophages. The alveoli immediately adjacent to the tumor nodules were dilated, and many subpleural blebs were present. In one section there was a small nodule close beneath the pleura, surrounded by a narrow zone of atelectatic alveoli bordered by emphysematous tissue. Extending from this latter area, along an interlobular septum, air could be traced into a subpleural bleb. Interstitial emphysema was seen in other areas in association with metastatic nodules, but was not generalized and was not observed about the hilar vessels. The tumor was a rapidly growing osteogenic sarcoma with a pronounced tendency to invade the blood vessels. Degenerative changes were marked. Sections from the larger necrotic pleural nodules showed complete infarct-like necrosis with extensive hemorrhage into and around the tumor. A few reactive cells were present, but the necrosis appeared very recent.

CASE II: White male, age 23. On Aug. 5, 1946, an attempt was made to remove a large infiltrating mass from the left side of the neck, which had been troublesome, off and on, for about ten years. It was not possible, however, to remove all of the recognizable tumor tissue because of extensive invasion of the deep structures of the neck. The histopathological report on the tissue removed at operation was fibrosarcoma.

Pulmonary metastases were first observed on the roentgenograms on Sept. 25, 1946. On Dec. 30, 1946, a bilateral pneumothorax was observed on a routine follow-up film.

Fig. 3. Case II: Persistent pneumothorax and metastatic involvement of both lungs (two hundred and thirteenth postoperative day, sixteen days before death).

In spite of the slowly increasing pneumothorax and the increase in the number and size of the metastatic nodules in both lungs (Fig. 3), the patient remained fairly comfortable. He did, however, complain of some shortness of breath on slight exertion and of considerable tenacious mucus in his throat. It was necessary for him to cough and clear

Fig. 4. Case III: Numerous metastatic nodules in both lungs, left-sided pneumothorax, and obliteration of costophrenic angles by pleural reaction.

his throat frequently in order to maintain an airway. He remained ambulatory until two days before his death, by respiratory failure, March 22, 1947.

*Necropsy:* The body was well developed but emaciated. A 10-cm. scar was present in the left superior cervical triangle, but no palpable tumor was noted. There was a bilateral pneumothorax. The lungs were partially collapsed and not in contact with the rib cage, although in parts they were held to the chest wall by scattered, easily broken, fibrous apical adhesions. At the level of the third rib was a rounded extrapleural mass which was in apposition with but did not erode the rib.

The lungs together weighed 1,150 gm. The pleura was thickened, with stringy fibrinous deposits over the posterolateral portion of each lower lobe. The surface was irregular, with subpleural pockets of air and fluid measuring up to 4 cm. in diameter. At the left apex was a thin-walled bleb which filled readily with fluid when the lungs were filled by intratracheal injection. Tumor had massively invaded the lungs and cystic degeneration was common in the nodules. There were air spaces in the sheaths of the pulmonary vessels extending to the hilum.

Microscopically, multiple sections of the lungs showed numerous metastatic fibrosarcoma nodules invading and replacing the parenchyma. The tumor was well vascularized, with a decided tendency to surround and invade the vessels. About the margin of the tumor nodules was a narrow zone of compressed alveoli bordered by emphysematous areas. Leading from these areas of emphysema were perivascular spaces where air had dissected through the interstitial tissue to pass to the numerous subpleural blebs and toward the hilum. The walls of some of these blebs were very thin, being formed by only a few strands of connective tissue and pleural mesothelium. In others the blebs were formed beneath pleura thickened by long-standing fibrosis and acute fibrinopurulent exudate.

CASE III: White male, age 23. On Sept. 12, 1944, a specimen was removed from a large inoperable retroperitoneal mass in the left lower quadrant of the abdomen. The histopathological diagnosis was angiosarcoma. The patient's course was steadily downhill following the biopsy and on Oct. 21, 1944, a chest roentgenogram revealed a marked increase in the number and size of the metastatic nodules that had been known to exist in both lungs for several weeks. On Feb. 7, 1945, the patient suddenly experienced pain in the chest, with dyspnea, weakness, and prostration. A roentgenogram made three days later (Fig. 4) revealed pneumothorax on the left side. On Feb. 27 sudden sharp parasternal pain and marked dyspnea occurred. The patient's condition continued critical until his death on March 22.

*Necropsy:* The subject was a well developed, emaciated white male, with a 14 × 11 × 9-cm. retroperitoneal mass, the primary tumor, which had produced displacement of the adjacent organs. Numerous metastatic nodules were present in the lymph nodes, the liver, lumbar vertebrae, sacrum, and ilium.

There was a tension pneumothorax on the left, with air trapped in the upper third of the pleural cavity. The rest of the pleural space was obliterated by fibrous adhesions and by tumor which had grown from parenchymatous nodules through the pleura to invade the lateral chest wall. The whole right pleural cavity was thus obliterated. One of the tumor nodules on the posterolateral surface of the left lung, midway between the base and apex of the lower lobe, was completely perforated to form a fistula, 0.6 cm. in diameter, into the free pleural cavity. Section of the lungs revealed massive tumor replacement.

Microscopically, the lungs showed numerous well circumscribed angiosarcomatous nodules, two of which grew directly beneath the pleura. The tumor had compressed the surrounding tissue, producing rather broad zones of atelectasis. Between these areas there was vascular engorgement and pulmonary edema. There was little alveolar ectasia and no evidence of interstitial emphysema.

## COMMENT

The not infrequent occurrence of spontaneous pneumothorax in apparently healthy persons (2) indicates that anatomical and physical factors play a much more important role in the production of

this condition than is generally believed. The presence of certain disease processes only renders the tissues more vulnerable to the accidental rupture of alveolar walls and the consequent escape of air into the interstitial spaces and pleural cavity.

Macklin and Macklin (3, 4), in reports of their extensive experimental studies on cats, have described two types of bases for the individual alveolar sacs. One type, which they call a "partitional" base, serves to separate adjacent sacs. Rupture of such a partition would permit the passage of air into the adjoining alveolus without harmful effect. The other type of base, referred to as "non-partitional," rests directly on connective tissue. The "non-partitional" bases are regarded as anatomic weak spots by Macklin and Macklin, and they have shown that rupture of these bases permits the escape of alveolar air into the connective tissue, with the production of pulmonic interstitial emphysema. Once interstitial emphysema is established, air may travel in the perivascular connective-tissue spaces toward the mediastinum or toward the visceral pleura. In either event, if the degree of interstitial emphysema is sufficient to produce a mediastinal or visceral pleural bleb, its rupture would result in pneumothorax.

Macklin and Macklin are also of the opinion that "air continues to leak as long as the factor initiating the original break is operative," and that "once the leakage has begun, the pressure necessary to continue the leak need not be so high as that initiating the rupture."

No single mechanism affords an explanation for all cases of pneumothorax associated with metastatic tumors. Occasionally, as in Case III, a bronchopleural fistula results from necrosis of a subpleural nodule, but this obvious explanation cannot be evoked in all cases. In Case I there were several friable, necrotic tumor nodules extending through the pleura from the lungs, but no actual fistulous tract was demonstrated. Furthermore, the absence of inflammatory changes dated the necrosis as of rather recent origin, at least of more recent origin than the pneumothorax, which was present for several weeks, and argues against necrosis as the process which provided a direct pathway for the escape of air into the pleural spaces.

Subpleural bleb formation and interstitial emphysema were striking in Cases I and II. Macklin and Macklin have shown that interstitial emphysema is frequently the underlying factor in the development of subpleural and mediastinal emphysema. They and others (5) have shown that relatively small sudden changes in intra-alveolar pressure, such as are produced by forced expiratory movements, coughing, sneezing, straining at the stool, attempts at resuscitation etc., may produce alveolar overdistention plus changes in venous pressure to the extent that a pressure gradient is established which favors the rupture of the alveolar bases and dissemination of air into and along the pulmonary vascular sheaths. The intrathoracic pressure during forced expiration is of considerable magnitude, actually amounting to 40–50 mm. of mercury during the conditions of the Valsalva experiment.

In our first two cases, the numerous tumor nodules growing at the periphery of the lungs had produced partial bronchiolar obstruction. Through a ball-valve action, overdistention of the alveoli resulted, with concomitant tearing of the walls to permit passage of air along the interlobular septa to the pleura, where blebs were formed (Fig. 5). While the final point of rupture was not demonstrated at autopsy, it was felt that breaking of the peripheral visceral or mediastinal pleura resulted in the pneumothorax.

These necessary conditions of bronchiolar obstruction by tumor would seem to be present in all cases of massive metastatic involvement of the lungs. Alveolar ectasia and interstitial emphysema should be common in such cases. Indeed, localized emphysema is frequent in the proximate areas of metastatic foci; yet only

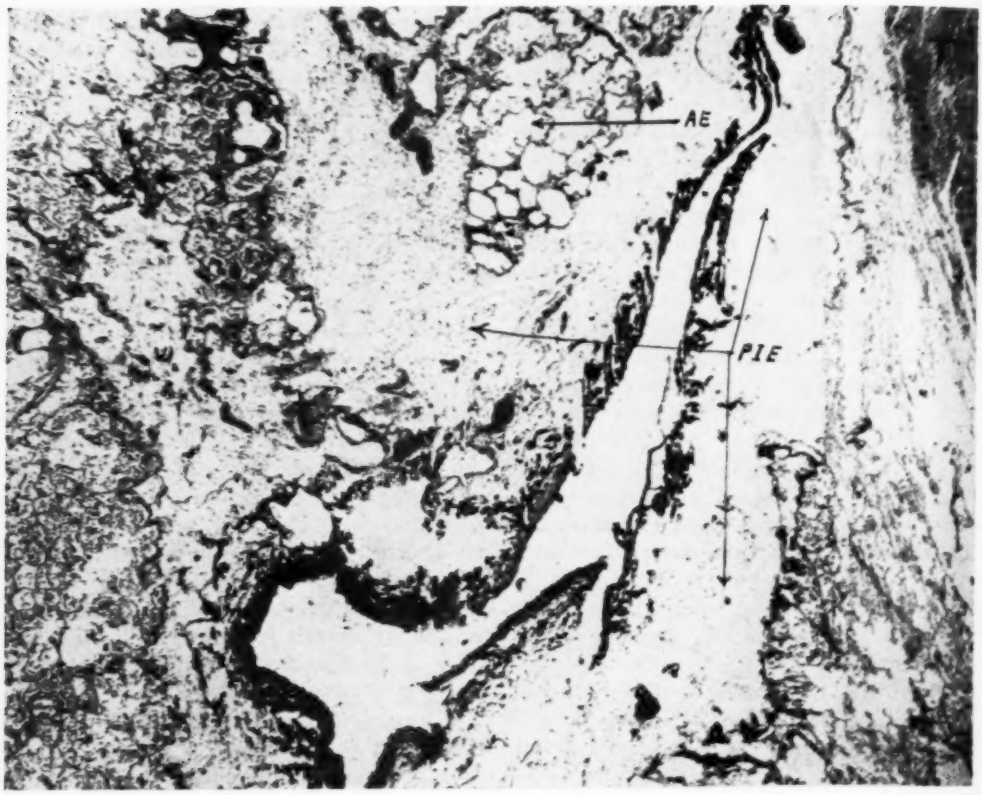


Fig. 5. Case II: Section from the lung showing a metastatic tumor nodule in the upper portion of the field. Air spaces can be seen in the interlobular interstitial spaces surrounding the blood vessels. AE. Alveolar ectasia. PIE. Pulmonic interstitial emphysema. T. Tumor nodule.

occasionally may these nodules be strategically enough located to produce pressures sufficient to cause significant interstitial emphysema, since normally there is intercommunication between alveolar lobules which would allow sufficient deflation through the respiratory tree to prevent the development of excessive local pressures.

Another factor which might play a role is local alteration of the tensile strength of connective tissues due to interference with blood supply. In these cases the rapidly growing tumor had a marked tendency to invade and obliterate blood vessels, and it is conceivable that edema and poor nourishment of the tissues made them more liable to tearing and separation.

Still another factor to be considered is the effect of muscular effort. In Cases I and II the patients were ambulatory and active at the time of inception of the pneumothorax. This alone would permit a greater amplitude of intrabronchial and intrathoracic pressures than in patients at bed rest.

## SUMMARY

Three cases of spontaneous pneumothorax associated with metastatic sarcoma in the lungs have been described. A review of the available literature on the subject has indicated that only two similar cases have been previously reported. Since neither spontaneous pneumothorax nor pulmonary metastatic sarcoma is in itself a rare condition, we are unable to explain why the combination of the two is not more frequently seen. It would seem that

the mechanism for the production of pulmonic interstitial emphysema and pneumothorax is operative in all cases of metastatic neoplasm of the lungs.

ADDENDUM: A fourth case is at the present time under observation. The patient, an 18-year-old white male, had a high amputation for osteogenic sarcoma of the femur on July 13, 1947. Pulmonary metastases were first seen on the chest roentgenogram in October 1947. Left-sided pneumothorax developed in March 1948. It may be possible to report this case in detail at a later date.

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SUMARIO

**Neumotorax Espontáneo Asociado a Metástasis Sarcomatosas. Tres Observaciones**

Este comunicación versa sobre tres casos de neumotórax espontáneo asociado a metástasis sarcomatosas. Un repaso de la literatura accesible indica que sólo se han comunicado previamente dos casos semejantes. Dado que ni el neumotórax espontáneo ni el sarcoma metastático pulmonar son estados raros de por sí, parece extraño que no se vea más frecuentemente la combinación de los dos.

Ningún mecanismo aislado permite explicar todos los casos de neumotórax asociado a metástasis neoplásicas. En uno de los casos ahora comunicados una fístula broncopulmonar procedía del esfacelo de un nódulo subpleural. En los otros dos casos los numerosos nódulos neoplásicos en la periferia de los pulmones habían producido obstrucción bronquiolar parcial. Por un efecto de válvula de bolas, sobrevino distensión de los alvéolos, con desgarro concomitante de las paredes para dejar pasar el aire a lo largo de los tabiques interlobulares a la pleura, en la que se formaron flictenas. Aunque no se descubrió en la autopsia el punto final de rotura, parece que la fractura periférica de la pleura visceral o mediastínica aportó el neumotórax. Parece que el mecanismo productor del enfisema intersticial del pulmón y del neumotórax se halla presente en todos los casos de metástasis neoplásicas en los pulmones.

# A Simple Method for Computing the Volume of the Human Gallbladder[1]

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THE LACK OF understanding that prevails in the field of motor dysfunctions of the gallbladder—we might better say, of the extrahepatic biliary system, to which it belongs—is in large part dependent upon three factors:

1. Deficient knowledge of the physiology of the extrahepatic biliary system, a matter which only in recent decades is receiving substantial elucidation.

2. Lack of standardization in radiological technics applied to the study of the process of discharge of gallbladder contents, especially in that part dealing with the cholecystokinetic meal, and the intervals and length of time in which the evacuation is observed.

3. Absence of numerical data in most studies of the emptying of the gallbladder.

Reading the articles on motor function of the gallbladder published since the onset of the cholecystographic era, one is amazed to find two really different systems of approaching the subject: on one hand, that of Boyden and his co-workers, using a definite method of study and a procedure for estimating the volume of the gallbladder for more than twenty years; on the other hand, a variety of heterogeneous technics, without numerical criteria to evaluate the course of emptying.

A method for determining the volume of the gallbladder was presented by Boyden (1) in 1926. It is hard to understand why such a method has not been systematically used by all authors that have treated the subject. Without an adequate method and with no basis of measures and numbers, they have lost themselves in the slippery field of adjectives and variable impressions. Boyden wrote in 1926: "A graphic method of computing the volumes, suggested to the writer by Prof. E. T. Adams, of the Department of Biochemistry, was finally selected as the quickest and most accurate method. In theory this consisted of establishing the longitudinal axis of the cholecystogram and then determining the diameter at every fifth of an inch or less. The volume of the successive plinths could then be obtained by using the formula $\pi D^2/4$, $D$ being the length of a perpendicular. When added together these volumes gave the total amount of bile in the gallbladder. The application of the graphic method to this problem consisted in laying out a curve on co-ordinate paper so prepared that when successive $D$'s were transferred to ordinates and the corresponding abscissas plotted on co-ordinate paper, the area thus outlined, when measured with a planimeter, automatically gave the volume of the gallbladder in cubic inches."

After this mention of the procedure for computing the volume of the gallbladder, Boyden (2) received so many requests for information that he decided to give an example in an appendix to his work on the reaction of the human gallbladder to food. This was written by Prof. E. T. Adams. There is shown a tracing of a gallbladder shadow bisected longitudinally. A parallel $CD$ to the axis ($AB$) of the gallbladder is drawn. A series of perpendiculars to these two parallel lines are traced. On each perpendicular a distance above $CD$ is marked which is numerically equal to the area of the cross section of the bladder at the level where its tracing is intersected by the perpendicular. A smooth curve is passed through the points marked above. The area enclosed by the line $CD$ and the smooth curve is numerically equal to the volume of the gallbladder. This area is measured with a planimeter.

[1] Accepted for publication in December 1947.

Persons not inclined to mathematics may have had difficulty in understanding this explanation. The mention of the planimeter may have contributed to make things appear still more complicated. Finally, it was Boyden himself who said that the whole process of making a series of twenty cholecystograms and of calculating the volumes required ten to fifteen hours, "a circumstance which would seem to preclude its use as a clinical method."

tened. He said: "As a method of measuring absolute volume, therefore, its chief value consists in measuring the response of the gallbladder to those stimuli which induce contraction. But even in other cases its value is nearly as great, since it records the relative changes in the condition of the organ."

Boyden and Fuller (3), studying the anatomy and physiology of the gallbladder in children, made other observations. Ob-

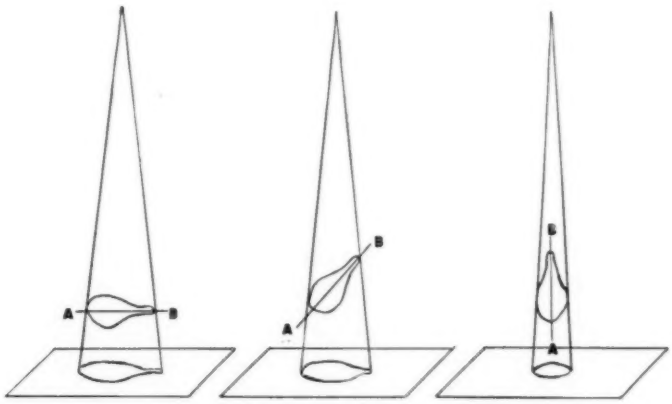


Fig. 1. Relation of the longitudinal axis of the gallbladder to the plane of the x-ray film, and its effect upon the cholecystographic shadow.

In view of the usefulness of a clinical method of computing the volume of the gallbladder, an attempt has been made to find another way of solving the mathematical problems so that anyone can do it easily.

Before proceeding to the description of this method, certain points should be emphasized.

### SOME IMPORTANT DATA

A method for computing the volume of the gallbladder which considers it as divided into a series of thin cylindrical portions of various diameters, comparable to a series of disks, assumes that the organ is round in cross section. Boyden (2) wisely warned that this assumption, while it is warranted during contraction of the gallbladder, is subject to error when the viscus is relaxed sufficiently to be flat-

taining cholecystograms with the child first lying prone and then on its right side, they noted that the computations of volume made from prone views are frequently based on foreshortened images, providing, therefore, an underestimate of absolute volume. They noted further that, since the shape of the gallbladder in cross section varies with the individual—being round in some patients and in others compressed either from side to side or anteroposteriorly—the absolute volume cannot be accurately calculated in the absence of data concerning both diameters. A mention should be made, also, of their finding that the frontal and sagittal diameters diminish proportionally after ingestion of food.

Some other points must be borne in mind: If the longitudinal axis ($AB$, in Fig. 1) of the gallbladder runs parallel to the

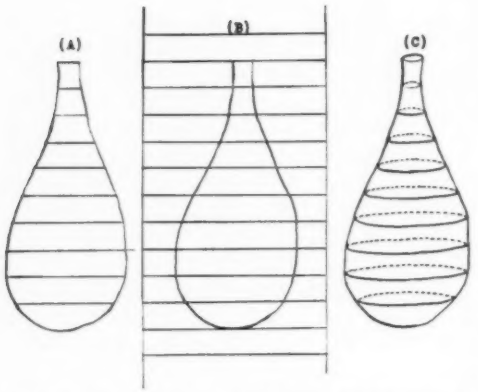


Fig. 2. Tracing of the gallbladder shadow, showing the division into "disks" for estimation of the volume. See text.

by a series of disks or thin cylindrical segments. Once the volume of each disk is established, it will be very easy, by adding them all, to obtain the total volume.

### EXPLANATION OF THE METHOD

The first step is to obtain a carefully traced outline of the gallbladder shadow shown in the film, using a transparent paper. By drawing in this figure a series of parallel and equidistant lines (Fig. 2, A) perpendicular to the axis of the cholecystogram—or else, placing the transparent paper upon a prepared lined paper (Fig. 2, B)—the area outlined is divided in a series of geometric figures, either rectangles or

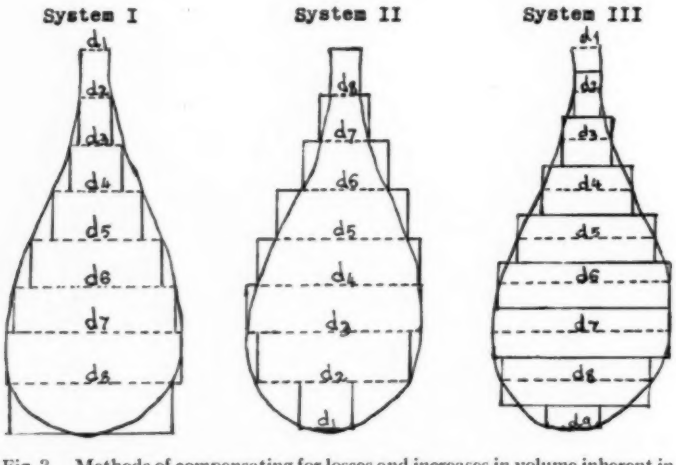


Fig. 3. Methods of compensating for losses and increases in volume inherent in division into "disks." See text.

plane of the x-ray film, in the position where the exposure is made, there will be a definite proportion between the size of the organ and its shadow. If, however, that axis is oblique in relation to the plane of the film, the shadow will be shortened. And if it happens that the axis is perpendicular to the plane of the film, the cholecystogram will be round.

After these considerations, the problem of estimating the volume of the gallbladder can be approached. We proceed from the theory that considers the gallbladder, for purposes of calculation, as if it were formed trapeziums, or segments of a circle or part of an ellipse.

When one considers the three dimensions of the gallbladder, it is clear that these parallel lines give origin to parallel planes (Fig. 2, C) which in turn divide the organ into a series of sections that resemble either cylinders or sections of cones, fragments of an ellipsoid, or portions of a sphere or less well defined solids. Since these sections have a slight height or thickness, the volume of each one is approximately the volume of a cylinder (like a disk or coin) of the same height and diameter.

Figure 3 shows how the losses and increases of volume, inherent to such a process of forming "disks" or "coins," are compensated. On careful analysis of what is demonstrated in the drawings, it may be inferred that the best system of calculation is III. In Systems I and II the diameter is traced in the superior and inferior part of the cylinder, respectively, while in System III it is assumed to pass through the center of the cylinder. In consequence, the first and last segments are reduced by half.

Hence, the computation will be made as follows:

$$V = \frac{v_1}{2} + v_2 + v_3 + v_4 + \ldots \frac{v_n}{2}$$

The volume of each "disk" or cylindrical segment is obtained by multiplying the area of the base ($\pi d^2/4$) by the height ($h$): $v = \pi d^2 h/4$.

As long as $h$ is constant—for the parallel planes are equidistant—it will be easy to make tables that provide the volume of each segment as a function of its diameter ($d$), the only variable element in such a formula. It is sufficient to measure the diameters and to look for the volume of each portion in the table (see p. 99). Adding these volumes as described above, a total is obtained. The last step is to multiply it by the factor supplied by the radiologist to compensate for the magnification of the image in the film. The volume is easily and quickly estimated.

The correction factor to compensate for the magnification of the image of the gallbladder in the x-ray plate is determined on the basis of two factors: the tube-film distance $D$ ($MO$ in Fig. 4), and the distance between the tube and the axis of the gallbladder $d'$ ($MN$ in Fig. 4). To evaluate the distance between the longitudinal axis of the gallbladder and the film $m$ ($NO$ in Fig. 4), the radiologist will make an estimate of the thickness of the abdominal wall and the position of the organ within the abdomen, and add to that figure the distance from the skin to the plane of the film (including the Potter-Bucky). Once $D$ and $d'$ are determined, a coefficient of linear amplification $c$ is obtained by dividing $d'$ by $D$: $c = d'/D$.

But the shadow of the gallbladder is enlarged not only in the longitudinal axis, but also in the transverse diameters. The longitudinal and transverse

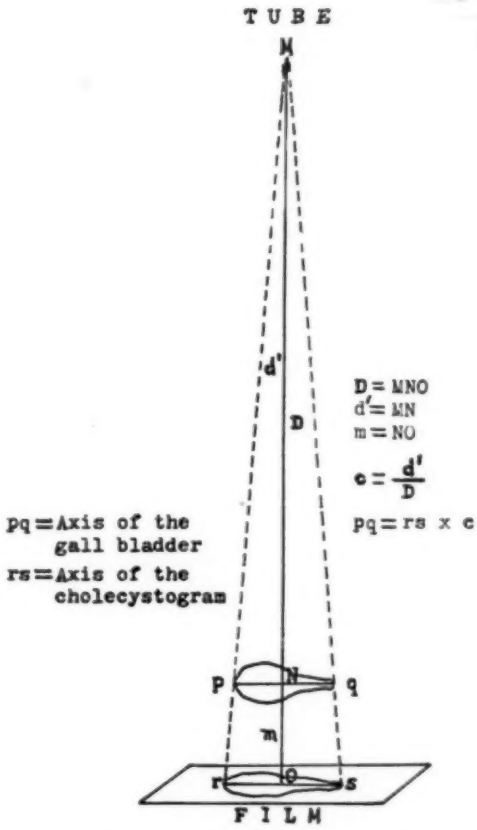


Fig. 4. Determination of the correction factor, explained in detail in the text.

measures made on the gallbladder shadow to calculate the volumes of the segments, are reduced to their original sizes by multiplying both the diameters ($d$) and heights ($h$) by the coefficient ($c$) in the formula mentioned above, $V = \pi d^2 h/4$, to obtain the *corrected volume*

$$V' = \frac{\pi(dc \times dc)hc}{4} \text{ or } \frac{\pi d^2 h}{4} \times c^3.$$

So the *correction factor* is that coefficient raised to the third power ($c^3$).

An example may make things easier to understand. When the tube-film distance ($D$) is 80 cm., and the distance between the tube and the axis of the gallbladder ($d'$) is 72 cm., the coefficient of amplification will be 0.9. In this case a segment which measures, in the outlined shadow, 20 mm. in diameter and 8 mm. in height, corresponding to 2.513, will have in fact $20 \times 0.9 = 18$ mm. (diameter), and $8 \times 0.9 = 7.2$ mm. (height), and its volume will be 1.832.

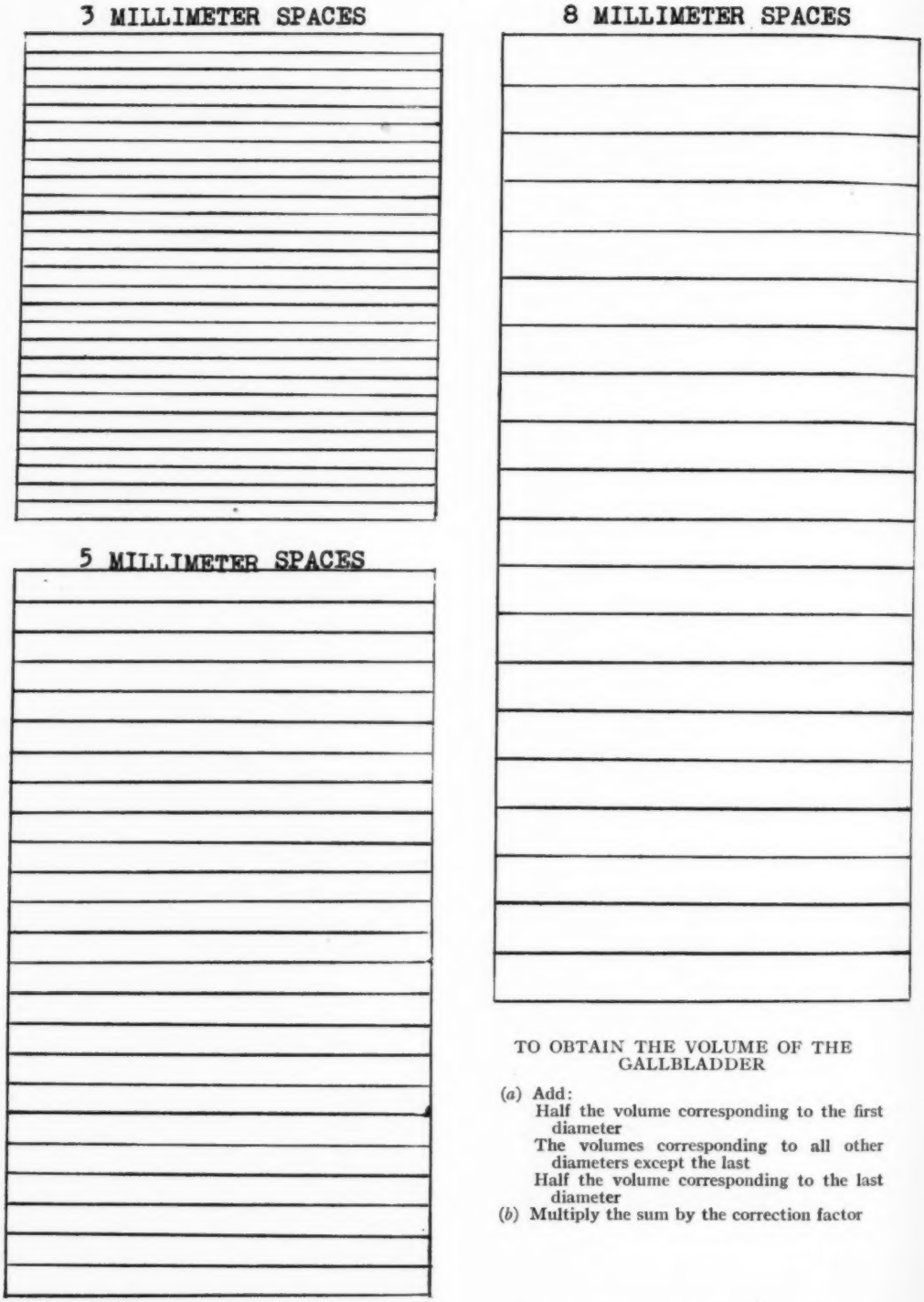
3 MILLIMETER SPACES
8 MILLIMETER SPACES
5 MILLIMETER SPACES
TO OBTAIN THE VOLUME OF THE GALLBLADDER
(a) Add:
Half the volume corresponding to the first diameter
The volumes corresponding to all other diameters except the last
Half the volume corresponding to the last diameter
(b) Multiply the sum by the correction factor

Fig. 5. Sets of lines upon which to superimpose the tracings of the gallbladder shadow. With the aid of the accompanying table and the correction factor the volume is obtained.

TABLE SHOWING VOLUMES IN RELATION TO DIAMETERS

| Diameter in Millimeters | Volumes in Cubic Centimeters | | |
|---|---|---|---|
| | 8 mm. spaces | 5 mm. spaces | 3 mm. spaces |
| 1 | 0.006 | 0.003 | 0.002 |
| 2 | 0.025 | 0.015 | 0.004 |
| 3 | 0.056 | 0.035 | 0.009 |
| 4 | 0.100 | 0.062 | 0.037 |
| 5 | 0.141 | 0.098 | 0.058 |
| 6 | 0.226 | 0.141 | 0.084 |
| 7 | 0.307 | 0.192 | 0.115 |
| 8 | 0.401 | 0.251 | 0.150 |
| 9 | 0.508 | 0.318 | 0.190 |
| 10 | 0.628 | 0.392 | 0.235 |
| 11 | 0.760 | 0.475 | 0.285 |
| 12 | 0.904 | 0.565 | 0.339 |
| 13 | 1.061 | 0.663 | 0.398 |
| 14 | 1.231 | 0.769 | 0.461 |
| 15 | 1.412 | 0.883 | 0.530 |
| 16 | 1.608 | 1.005 | 0.603 |
| 17 | 1.815 | 1.134 | 0.680 |
| 18 | 2.035 | 1.272 | 0.763 |
| 19 | 2.267 | 1.417 | 0.850 |
| 20 | 2.513 | 1.570 | 0.942 |
| 21 | 2.770 | 1.731 | 1.038 |
| 22 | 3.040 | 1.900 | 1.140 |
| 23 | 3.323 | 2.077 | 1.246 |
| 24 | 3.618 | 2.261 | 1.357 |
| 25 | 3.926 | 2.454 | 1.472 |
| 26 | 4.246 | 2.654 | 1.592 |
| 27 | 4.579 | 2.862 | 1.717 |
| 28 | 4.924 | 3.078 | 1.847 |
| 29 | 5.483 | 3.302 | 1.981 |
| 30 | 5.654 | 3.534 | 2.120 |
| 31 | 6.036 | 3.773 | 2.264 |
| 32 | 6.432 | 4.021 | 2.412 |
| 33 | 6.840 | 4.276 | 2.565 |
| 34 | 7.262 | 4.539 | 2.723 |
| 35 | 7.695 | 4.810 | 2.886 |
| 36 | 8.141 | 5.099 | 3.053 |
| 37 | 8.600 | 5.376 | 3.225 |
| 38 | 9.071 | 5.670 | 3.402 |
| 39 | 9.555 | 5.972 | 3.573 |
| 40 | 10.052 | 6.283 | 3.769 |
| 41 | 10.560 | 6.601 | 3.960 |
| 42 | 11.081 | 6.927 | 4.156 |
| 43 | 11.616 | 7.260 | 4.356 |
| 44 | 12.162 | 7.601 | 4.561 |
| 45 | 12.721 | 7.951 | 4.770 |
| 46 | 13.292 | 8.318 | 4.985 |
| 47 | 13.877 | 8.673 | 5.204 |
| 48 | 14.474 | 9.046 | 5.428 |
| 49 | 15.084 | 9.427 | 5.656 |
| 50 | 15.707 | 9.816 | 5.890 |
| 51 | 16.340 | 10.213 | 6.128 |
| 52 | 16.987 | 10.617 | 6.370 |
| 53 | 17.647 | 11.029 | 6.618 |
| 54 | 18.319 | 11.450 | 6.870 |
| 55 | 19.004 | 11.878 | 7.126 |

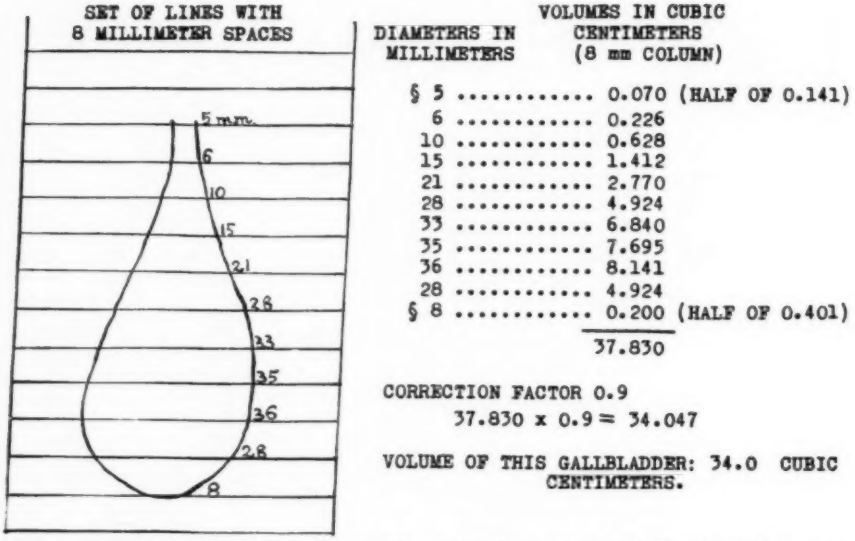


Fig. 6. A practical application of the author's method of computation of the volume of the gallbladder.

$$\text{Volume found: } \frac{\pi \times 20^2 \times 8}{4} = 2.513$$

$$\text{Corrected volume: } \frac{\pi \times 18^2 \times 7.2}{4} = 1.832$$

Multiplying the volume found in the table (2.513) by the cube of the coefficient of amplification ($0.9^3 = 0.729$), we shall have the corrected volume (1.832).

Multiplying the sum of the separate volumes by this correction factor we shall obtain the volume of the gallbladder.

To save time and labor we have prepared a table of correction factors to be used when the tube-film distance is 80 cm. The only thing to do is to estimate *the distance between the axis of the gallbladder and the film* (*m*, in the figure). The cube of the coefficient of amplification, that is, the correction factor, is already calculated:

CORRECTION FACTORS

(Tube-film Distance, 80 cm.)

| Distance from the Gallbladder Axis to the Film | Correction Factor |
|---|---|
| 4 cm. | 0.85 |
| 5 cm. | 0.82 |
| 6 cm. | 0.79 |
| 7 cm. | 0.75 |
| 8 cm. | 0.72 |
| 9 cm. | 0.68 |
| 10 cm. | 0.65 |
| 11 cm. | 0.63 |
| 12 cm. | 0.61 |
| 13 cm. | 0.58 |
| 14 cm. | 0.56 |

Three sets of lines have been prepared (Fig. 5) with 8-mm., 5-mm., and 3-mm. spaces, respectively, to be used under the transparent paper on which the tracings of the cholecystogram are made. The first (8 mm.) is designed for gallbladder shadows of greater length (more than 9 cm. longitudinal axis) or with regular and apparently symmetric outlines. The second set (5 mm.) will be more convenient in case of shorter or bulging gallbladders, with less regular tracings. The last (3 mm.) will be used for small images, especially those obtained in the final period of emptying of the gallbladder, or to estimate portions of the shadow not adjusted within the parallel lines of the two former sets. A table has also been prepared for the three sets of lines showing the volumes in relation to the diameters.

## PRACTICAL APPLICATION

### (Figure 6)

To estimate the volume of the gallbladder according to the procedure described above:

1. Study carefully the cholecystogram, and reproduce the outlines exactly on a sheet of transparent (cellophane) paper.

2. Transfer the transparent paper to the selected set of lines, so that the axis of the outlined cholecystogram will be perpendicular to the parallel lines.

3. Adjust the image to the lines in such a way as to make its lower outline coincide with or run slightly over a line.

If the line traced in the upper part of the figure does not coincide with another parallel line of the set, when the 8 mm. pattern is used, for example, try one of the 5 mm. spaces. If, even doing so, a part of the figure goes beyond the line, make an ink trace separating this zone, and estimate its volume using the 3-mm. set of lines. Add this to the total volume.

4. Be sure the transparent paper does not slip over the lined paper; fasten it with metal clips.

5. Measure, with a ruler divided in millimeters, each diameter and make a note of the measurements.

6. Look for the volume corresponding to each diameter in the table containing columns for all three sets of lines.

7. Add the individual volumes as follows: half of the volume corresponding to the first diameter (that line traced in the upper part of the cholecystogram outlined); the volumes corresponding to all other diameters, except the last; half of the volume corresponding to the last diameter (which coincides with the bottom line of the tracing).

8. Once the addition is made, multiply the total by the correction factor, supplied by the radiologist, based on the tube-film distance and the type and thickness of the patient.

The final result is expressed in cubic centimeters and fractions thereof. To simplify matters, only the first figure to the right of the decimal point need be used. For example, instead of 34.216 (that is, 34 c.c. and 216 c.mm.), 34.2 may be used.

Finally, two warnings: It would be wrong to add the measurements of the diameters and compute the total volume using this sum. It would also be wrong to divide by 2 the first and last diameters, instead of dividing by 2 the volumes corresponding thereto.


## SUMMARY

The writer describes a simple method of computing the volume of the gallbladder. A tracing of the cholecystogram, made on transparent paper, is placed upon a ruled paper with parallel and equidistant lines, thus dividing it into a series of segments or "disks." The diameters of these segments are measured in millimeters with the aid of a ruler, and the volumes corresponding to the diameters of these segments are found in an accompanying table. The sum of these individual volumes is multiplied by a correction factor (to compensate for magnification of the image shown in the film), and the result is the volume of the gallbladder in cubic centimeters.


EDITOR'S NOTE: Through the courtesy of the author this manuscript was submitted through Dr. E. A. Boyden. Dr. Boyden has expressed himself as most happy to state that the new short method markedly reduces the labor of computing volumes from tracings of cholecystograms and this without loss of accuracy. Using both methods upon samples involving volumes of 40 c.mm., he found the computations to agree within a fraction of a millimeter.

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*(For Spanish Summary, see following page)*

SUMARIO

**Sencillo Método para Calcular el Volumen de la Vesícula Biliar**

El A. describe un método sencillo para calcular el volumen de la vesícula biliar humana. Sobre un papel rayado con líneas paralelas y equidistantes, que lo dividen en una serie de "discos" o segmentos, se coloca un calco, ejecutado en papel transparente, del colecistograma. Con la ayuda de una regla, se miden en milímetros los diámetros de los distintos discos y se buscan en la tabla que acompaña al artículo los volúmenes correspondientes a dichos diámetros. Multiplícase después la suma de los diversos volúmenes por un factor correctivo (para compensar la ampliación de la imagen reproducida en la radiografía), y el producto es el volumen de la vesícula biliar en centímetros cúbicos.

Este método fué ideado con mira a evitar las dificultades matemáticas que encierra el procedimiento descrito por Boyden hace unos 20 años, habiendo sido ensayado por dicho autor y resultado muy exacto.

# A New Standard for Heart Size Measurement[1]

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A GREAT DEAL HAS been written on the roentgen mensuration of cardiac size. Many types of criteria have been proposed, but only two have survived the practical test of general use. Predictions based on height, weight, and age (3, 4, 5) are generally accepted as having reasonable accuracy, and are favored by most students of this subject. Curiously, the cardiothoracic index has also survived, in spite of the fact that all studies have shown it to be a poor criterion. For a long time I was disposed to dismiss this survival with a disparaging word about "old fogies who wouldn't keep up with progress," but I finally noticed that I often used the cardiothoracic index myself—especially when I had no direct access to the patient. This in turn set me to thinking whether, after all, height, weight, and age were in fact the most *convenient* data on which to base heart size prediction. Obviously they would commend themselves to the anthropologist, but to the radiologist data recorded on his film are manifestly more convenient. The transverse chest diameter is only one of several which have been tried (3, 4). As a second criterion, the length of the aerated lung column appeared to be simplest. The use of the transverse heart diameter is justified by the fact that no better correlation is obtained, while complexities are introduced, when area (or other measures) are used.

The following measures were employed: Height to the nearest half inch (designated by the symbol H); weight to the nearest pound (designated W); age at last birthday (designated A); sex (designated S); inside transverse diameter of the chest at the level of the junction of the left cardiac apical shadow with the diaphragmatic shadow (designated C); and the shortest length from the highest aerated point in the right apex to the highest level of the right diaphragmatic shadow (designated L). The transverse cardiac diameter (T) was measured by the broken line method (see Fig. 1).

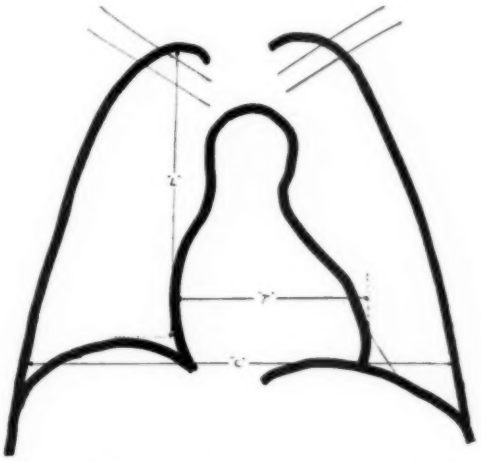

Fig. 1. Diagram to show measurements employed.

Five hundred chest films chosen roughly consecutively, but eliminating those with obvious disease, were studied by correlation analysis. The following is a brief outline of the statistical procedure employed. The 500 original observations were organized into correlation tables to calculate the standard deviations, product moments, and first order correlation coefficients. The multiple regression coefficients were determined by Doolittle's method of simultaneous equations from the product moments, and the multiple correlation coefficient and standard error of estimate were calculated from these. For full discussion of the procedure, the reader is referred to standard texts on statistical method, as, for example, that of Ezekiel (6, pp. 353–369). The use

[1] Read by title at the Thirty-third Annual Meeting of the Radiological Society of North America, Boston, Mass., Nov. 30–Dec. 5, 1947.

TABLE I: MEANS AND STANDARD DEVIATIONS OF VARIABLES

| Measure | Symbol | Mean | Standard Deviation |
|---|---|---|---|
| Height | H | 68.66 in. | 3.01 in. |
| Weight | W | 156.24 lb. | 25.33 lb. |
| Age | A | 34.21 yr. | 12.15 yr. |
| Transverse diameter of chest | C | 301.15 mm. | 22.06 mm. |
| Length of chest | L | 232.64 mm. | 22.94 mm. |
| Sex | S | ..... | 0.62 |
| Transverse diameter of heart | T | 127.08 mm. | 14.20 mm. |

of a non-quantitative variable (sex) introduced a minor complication. This was solved by following a procedure described by Ezekiel (6, p. 250): the arbitrary values of +1 and −1 were assigned to males and females, respectively, and the resulting function treated like any other quantitative variable. Since any two points in space may be joined by a straight line, the regression so determined is linear by definition. Tests for curvilinearity were made on the other regressions by methods of graphic approximation, but since these failed to show any significant curvilinearity in any variable, this procedure need not be further discussed.

TABLE II: FINAL REGRESSION EQUATIONS FOR THE PREDICTION OF TRANSVERSE CARDIAC DIAMETER

*Equation 1:* $T = 111.89 + 0.387W - 0.660H$
*Equation 2:* $T = 84.06 + 0.386W - 0.411H + 0.318A$
*Equation 3:* $T = 67.40 + 0.376C - 0.230L$
*Equation 4:* $T = 61.85 + 0.362C - 0.248L + 0.303A$
*Equation 5:* $T = 71.35 + 0.211W - 0.045H + 0.300A + 0.188C - 0.176L$
(subtract 3.11 if female)

Prediction formulae were originally made on the basis of (*1*) H and W; (*2*) H, W, and A; (*3*) C and L; (*4*) C, L, and A; (*5*) H, W, A, C, L, and S. Of these (*1*) and (*3*) were discarded, as age has a definite and material correlation with heart size. The predictions based on equations *2* and *4* are almost exactly equal in accuracy, the difference in standard error of estimate amounting to 0.16 mm. Equation *5* is only a trifle better than the others, having a

TABLE III: STATISTICAL CONSTANTS FOR EQUATIONS IN TABLE II

| Statistical Constant | Equation 1 | Equation 2 | Equation 3 | Equation 4 | Equation 5 |
|---|---|---|---|---|---|
| Correlation coefficient | 0.632 | 0.694 | 0.631 | 0.681 | 0.738 |
| Standard error of estimate | 11.01 | 10.27 | 11.02 | 10.43 | 9.66 |
| Coefficient of determination | 0.399 | 0.481 | 0.398 | 0.465 | 0.544 |

standard error of estimate 0.61 mm. smaller but this improvement is not worth the extra work. No evidence of a significant curvilinearity could be shown for any of the independent variables. Table III gives the statistical constants involved, Formula *2* tends to miss on very short-chested individuals with high diaphragms, while formula *4* tends to miss on very short, obese individuals; for these, formula *5* might be preferable. It should be remembered that these formulae will not ordinarily predict exactly the same transverse diameter for any given patient.

Tables IV and V give size predictions based on formulae *2* and *4* respectively. Instead of giving predictions for the average, the tables give the largest normal size (for 95 per cent of population), and any observation larger is to be considered as probably abnormal; *e.g.*, if a prediction value is 147 mm. and the measurement is 148 mm., the heart is probably enlarged. This value is obtained by adding two standard deviations or 21 mm. to the prediction so that, for comparison with prediction tables published by other essayists, 21 mm. must be subtracted from the values in Tables IV and V.

For those who prefer tables based on other standards, the original formulae are given in Table II.

At first glance, it might appear that predictions based on formula *4* would be relatively independent of the phase of respiration. This is not true. Films made in expiratory phase tend to predict a diameter smaller than those made in moderately full inspiration, although the heart diameter is greater in expiration. It is, therefore,

TABLE IV: PREDICTIONS FOR MAXIMUM NORMAL TRANSVERSE DIAMETER OF THE HEART BASED ON HEIGHT, WEIGHT, AND AGE*

(All Values Plus 2 Sigma from Prediction†)

| In. → | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lb. | | | | | | | | | | | | | | | | | | | |
| 80 | 124 | 124 | 123 | 123 | 122 | 122 | 122 | 121 | 121 | 120 | 120 | 119 | 119 | 119 | 118 | 118 | 117 | 117 | 117 |
| 90 | 128 | 127 | 127 | 127 | 126 | 126 | 125 | 125 | 125 | 124 | 124 | 123 | 123 | 123 | 122 | 122 | 121 | 121 | 120 |
| 100 | 132 | 131 | 131 | 130 | 130 | 130 | 129 | 129 | 128 | 128 | 128 | 127 | 127 | 126 | 126 | 126 | 125 | 125 | 124 |
| 110 | 136 | 135 | 135 | 134 | 134 | 134 | 133 | 133 | 132 | 132 | 131 | 131 | 131 | 130 | 130 | 129 | 129 | 129 | 128 |
| 120 | 139 | 139 | 139 | 138 | 138 | 137 | 137 | 137 | 136 | 136 | 135 | 135 | 135 | 134 | 134 | 133 | 133 | 132 | 132 |
| 130 | 143 | 143 | 142 | 142 | 142 | 141 | 141 | 140 | 140 | 140 | 139 | 139 | 138 | 138 | 138 | 137 | 137 | 136 | 136 |
| 140 | 147 | 147 | 146 | 146 | 146 | 145 | 145 | 144 | 144 | 143 | 143 | 143 | 142 | 142 | 141 | 141 | 141 | 140 | 140 |
| 150 | 151 | 151 | 150 | 150 | 149 | 149 | 149 | 148 | 148 | 147 | 147 | 146 | 146 | 146 | 145 | 145 | 144 | 144 | 144 |
| 160 | 155 | 154 | 154 | 154 | 153 | 153 | 152 | 152 | 152 | 151 | 151 | 150 | 150 | 150 | 149 | 149 | 148 | 148 | 147 |
| 170 | 159 | 158 | 158 | 158 | 157 | 157 | 156 | 155 | 155 | 155 | 155 | 154 | 154 | 153 | 153 | 153 | 152 | 152 | 151 |
| 180 | 163 | 162 | 162 | 161 | 161 | 161 | 160 | 160 | 159 | 159 | 159 | 158 | 158 | 157 | 157 | 156 | 156 | 156 | 155 |
| 190 | 166 | 166 | 166 | 165 | 165 | 164 | 164 | 164 | 163 | 163 | 162 | 162 | 162 | 161 | 161 | 160 | 160 | 159 | 159 |
| 200 | 170 | 170 | 170 | 169 | 169 | 168 | 168 | 167 | 167 | 167 | 166 | 166 | 165 | 165 | 165 | 164 | 164 | 163 | 163 |
| 210 | 174 | 174 | 173 | 173 | 173 | 172 | 172 | 172 | 171 | 170 | 170 | 170 | 169 | 169 | 168 | 168 | 168 | 167 | 167 |
| 220 | 178 | 178 | 177 | 177 | 176 | 176 | 176 | 175 | 175 | 174 | 174 | 174 | 173 | 173 | 172 | 172 | 171 | 171 | 171 |
| 230 | 182 | 182 | 181 | 181 | 180 | 180 | 179 | 179 | 179 | 178 | 178 | 177 | 177 | 177 | 176 | 176 | 175 | 175 | 175 |
| 240 | 186 | 185 | 185 | 185 | 184 | 184 | 183 | 183 | 182 | 182 | 182 | 181 | 181 | 180 | 180 | 180 | 179 | 179 | 178 |
| 250 | 190 | 189 | 189 | 188 | 188 | 188 | 187 | 187 | 186 | 186 | 186 | 185 | 185 | 184 | 184 | 183 | 183 | 183 | 182 |

* Predictions for age 40; for each 10 years difference add or subtract 3 mm.

† In the preparation of most prediction tables, the *average* value is given, with a *range* which must be added to this value to give the limits in which normal patients will probably fall. In Tables IV and V, the prediction given is the average plus the range (the range is 21 mm.), so as to give the maximum limit directly, thus eliminating the mental arithmetic usually required. For average value, 21 mm. must be subtracted, and for minimum value, 42 mm. must be subtracted from the table value. Since most doctors are interested in enlargements of the cardiac silhouette, this method of presenting the values is most advantageous, but of course it must be remembered that the value given is the *top limit* of normal.

TABLE V: PREDICTIONS FOR MAXIMUM NORMAL TRANSVERSE DIAMETER OF THE HEART, BASED ON TRANSVERSE DIAMETER OF THE CHEST AND LENGTH OF AERATED LUNG AND AGE*

(All Values Plus 2 Sigma from Prediction†)

| T.D. →230 | 240 | 250 | 260 | 270 | 280 | 290 | 300 | 310 | 320 | 330 | 340 | 350 | 360 | 370 | 380 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| L. | | | | | | | | | | | | | | | |
| 140 | 143 | 147 | 151 | 154 | 158 | 162 | 165 | 169 | 172 | 176 | 180 | 183 | 187 | 191 | 194 | 198 |
| 150 | 141 | 145 | 148 | 152 | 156 | 159 | 163 | 166 | 170 | 174 | 177 | 181 | 185 | 188 | 192 | 195 |
| 160 | 139 | 142 | 146 | 149 | 153 | 157 | 160 | 164 | 168 | 171 | 175 | 178 | 182 | 186 | 189 | 192 |
| 170 | 136 | 140 | 143 | 147 | 151 | 154 | 158 | 161 | 165 | 169 | 172 | 176 | 180 | 183 | 187 | 190 |
| 180 | 134 | 137 | 141 | 144 | 148 | 152 | 155 | 159 | 163 | 166 | 170 | 173 | 177 | 181 | 184 | 188 |
| 190 | 131 | 135 | 138 | 142 | 146 | 149 | 153 | 156 | 160 | 164 | 167 | 171 | 175 | 178 | 182 | 185 |
| 200 | 129 | 132 | 136 | 139 | 143 | 147 | 150 | 154 | 158 | 161 | 165 | 168 | 172 | 176 | 179 | 183 |
| 210 | 126 | 130 | 133 | 137 | 141 | 144 | 148 | 152 | 155 | 159 | 162 | 166 | 170 | 173 | 177 | 181 |
| 220 | 124 | 127 | 131 | 135 | 138 | 142 | 145 | 149 | 153 | 156 | 160 | 164 | 167 | 171 | 174 | 178 |
| 230 | 121 | 125 | 128 | 132 | 136 | 139 | 143 | 147 | 150 | 154 | 157 | 161 | 165 | 168 | 172 | 176 |
| 240 | 119 | 122 | 126 | 130 | 133 | 137 | 140 | 144 | 148 | 151 | 155 | 159 | 162 | 166 | 169 | 173 |
| 250 | 116 | 120 | 123 | 127 | 131 | 134 | 138 | 142 | 145 | 149 | 152 | 156 | 160 | 163 | 167 | 171 |
| 260 | 114 | 117 | 121 | 125 | 128 | 132 | 136 | 139 | 143 | 146 | 150 | 154 | 157 | 161 | 164 | 168 |
| 270 | 111 | 115 | 119 | 122 | 126 | 129 | 133 | 137 | 140 | 144 | 148 | 151 | 155 | 158 | 162 | 166 |
| 280 | 109 | 112 | 116 | 120 | 123 | 127 | 131 | 134 | 138 | 141 | 145 | 149 | 152 | 156 | 160 | 163 |
| 290 | 106 | 110 | 114 | 117 | 121 | 124 | 128 | 132 | 135 | 139 | 143 | 146 | 150 | 153 | 157 | 161 |
| 300 | 104 | 107 | 111 | 115 | 118 | 122 | 126 | 129 | 133 | 136 | 140 | 144 | 147 | 151 | 155 | 158 |
| 310 | 101 | 105 | 109 | 112 | 116 | 120 | 123 | 127 | 130 | 134 | 138 | 141 | 145 | 149 | 152 | 156 |
| 320 | 99 | 103 | 106 | 110 | 113 | 117 | 121 | 124 | 128 | 132 | 135 | 139 | 142 | 146 | 150 | 153 |

* Predictions for age 40; for each 10 years difference add or subtract 3 mm.
† See footnote †, Table IV.

essential that the film be taken in moderately full inspiration.

## CONCLUSION

While the use of the height-weight standard for the prediction of heart size is not objectionable, the use of measurements all of which are obtainable from a satisfactory radiograph has a necessary place in practice. A standard equal in value to the

height-weight standard is, therefore, presented for employment, based on the transverse diameter of the chest and the length of the aerated right lung column.

NOTE: Although both the editor of RADIOLOGY and the author feel that the publication of the original data and the details of arithmetic would not be worth the expenditure of the space required, the author will be glad to send a transcript of the original measurements, of which there are a few copies, to any researcher who wishes one.

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SUMARIO

**Nueva Regla para la Medición del Tamaño del Corazón**

Aunque no hay reparos que ofrecer al uso del patrón talla-peso para predecir el tamaño del corazón, el empleo de mediciones derivadas de una radiografía satisfactoria ocupa un puesto necesario en la práctica. En un estudio de 500 radiografías torácicas, las predicciones basadas en el diámetro interno transverso del tórax, el largo de la columna del pulmón derecho aereado y la edad del sujeto, mostraron una exactitud casi igual a las basadas en la talla, peso y edad. Las tablas adjuntas muestran las predicciones derivadas de ambos procedimientos.

# An Apparatus for Automatic Multiple Exposures[1]

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THERE ARE INCREASING demands for angiocardiographic examinations, a procedure which yields considerable information. Its importance for the study of cardiovascular lesions and for the differentiation of vascular from non-vascular mediastinal lesions has been established. A multiple-exposure technic is desirable.

Many attempts have been made to opacify the heart chambers and large blood vessels. Castellanos (1), examining infants, used two x-ray tubes at right angles to each other to obtain an anteroposterior and a lateral projection simultaneously with a single injection of contrast substance. Robb and Steinberg (2, 3) described a practical technical procedure whereby, with a single injection, two exposures are made in any one desired position. Two additional exposures can be obtained following a second injection in any other position. This may be designated as a two- or four-film technic. In 1940, Stewart and Ghiselin (4) published their paper on cinefluorography, and in 1941, Stewart, Breimer, and Maier (5) described a cineroentgenographic procedure with the aid of contrast substance to delineate the heart and large vessels. Sussman, Steinberg, and Grishman (6, 7) have devised multiple exposure technics, using (*a*) cineroentgenography, (*b*) fluororoentgenography, (*c*) a polygraph making four exposures on one 14 × 17-inch film, and (*d*) a wheel device, measuring 62 inches in diameter, on which are mounted eight 10 × 12-inch cassettes. Schwarzschild's (8) device for rapid serial radiography makes seven exposures in a minimum time of six seconds. Neuhauser and Jennings (9) designed an inexpensive cassette changer making use of springs, and Macht (10) constructed a long leaded tunnel which houses six 10 × 12-inch cassettes alongside of each other on one side of center. In Macht's device, the central area is not leaded, and the cassettes are manually displaced with each exposure. Temple, Dotter, and Steinberg (11), are using an automatic rapid change photofluorographic unit.

A comparison of the various multiple exposure technics in use at the present time leads to the following conclusions: The results from cineroentgenography and cinefluorography, while good, are not as good as those with any of the large-film technics. The many exposures with cineroentgenography and fluorography are desirable, but from the standpoint of detail they leave much to be desired. Any multiple-exposure technic using large films is superior to any multiple-exposure technic using miniature film, and, where more films are used, that procedure holds preference. The material exhibited recently by Temple, Dotter, and Steinberg, on 70-mm. film, was good, and with improvements, which are bound to come, it is conceivable that in the future their method may prove to be one of choice.

For eight years the writer employed the method described by Robb and Steinberg, using two films with each injection. The complete examination consisted of preliminary circulation tests and two injections of contrast substance in two different positions (on rare occasions, three injections); 14 × 17-inch films were used. A rotating anode was energized, and the exposures were made at a distance of 6 feet, with 400 ma., ranging in time from one-twentieth to one-tenth of a second. The results for the most part were good, but failures occurred. The making of exposures

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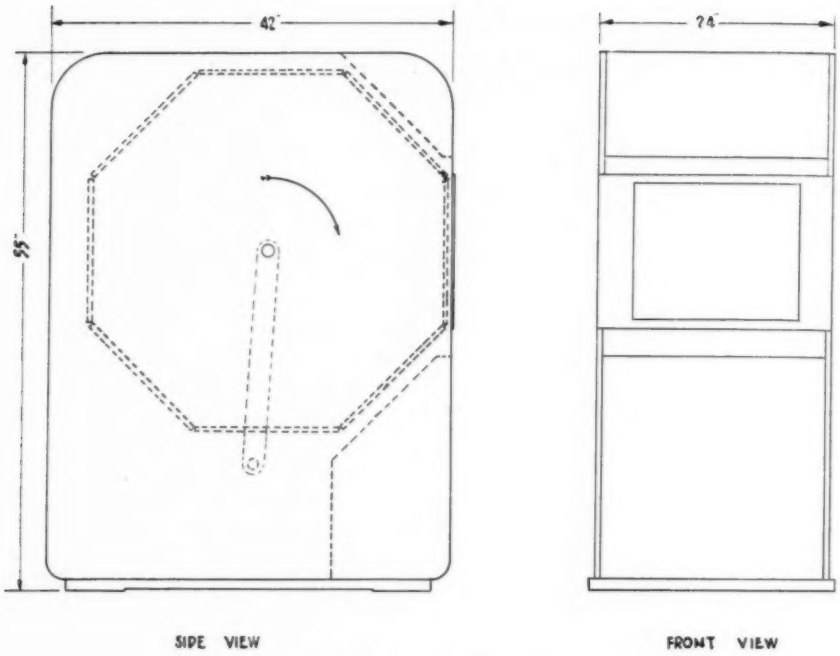


Fig. 1. Front and side views of the apparatus, showing the over-all dimensions.

based on circulation tests is not precise and has mixed in with it an element of chance. Circulation tests are, however, a necessary part of the procedure and should not be omitted. As a rule, when the circulation time is within normal limits, the angiocardiographic results are good; when it is prolonged, the results are usually poor. Aside from this, a comprehensive examination can be obtained only by multiple exposures; the more exposures the more complete the examination. Six-, seven-, or eight-film technics will yield more information than two films, for each injection. The information obtained from multiple exposures with a single injection may be adequate and thus obviate the need of a second or third injection.

In 1946, the interest of the late Dr. Isaac Liberson, then a resident in the writer's department, was aroused, and he in turn interested his father, the late Dr. Frank Liberson, in the problem. Discussions with these colleagues led to the conclusion that a multiple automatic-exposure device using 14 × 17-inch films at a distance of 6 feet would be highly desirable for angiocardiographic examinations. Accordingly, the elder Dr. Liberson, who had an especial interest in things mechanical, entered into collaboration with one of the owners of Medical Design, inventors and manufacturers of special equipment, with the result that there was designed and constructed an apparatus for the making of exposures automatically. This equipment has now been in use in the writer's department since June 1947.

Eight 14 × 17-inch films are mounted on an octagonal drum, rotated by a Geneva drive consisting of a rotating arm with two driving rollers attached to it. These rollers engage in slots which are fastened to the side of the drum. The rotating arm is driven by a motor with a suitable drive. A contact device provides for automatic exposure as soon as each film is rotated into place. The eight-film cycle is complete within eleven seconds. The long axes of the films are horizontal. There is also an

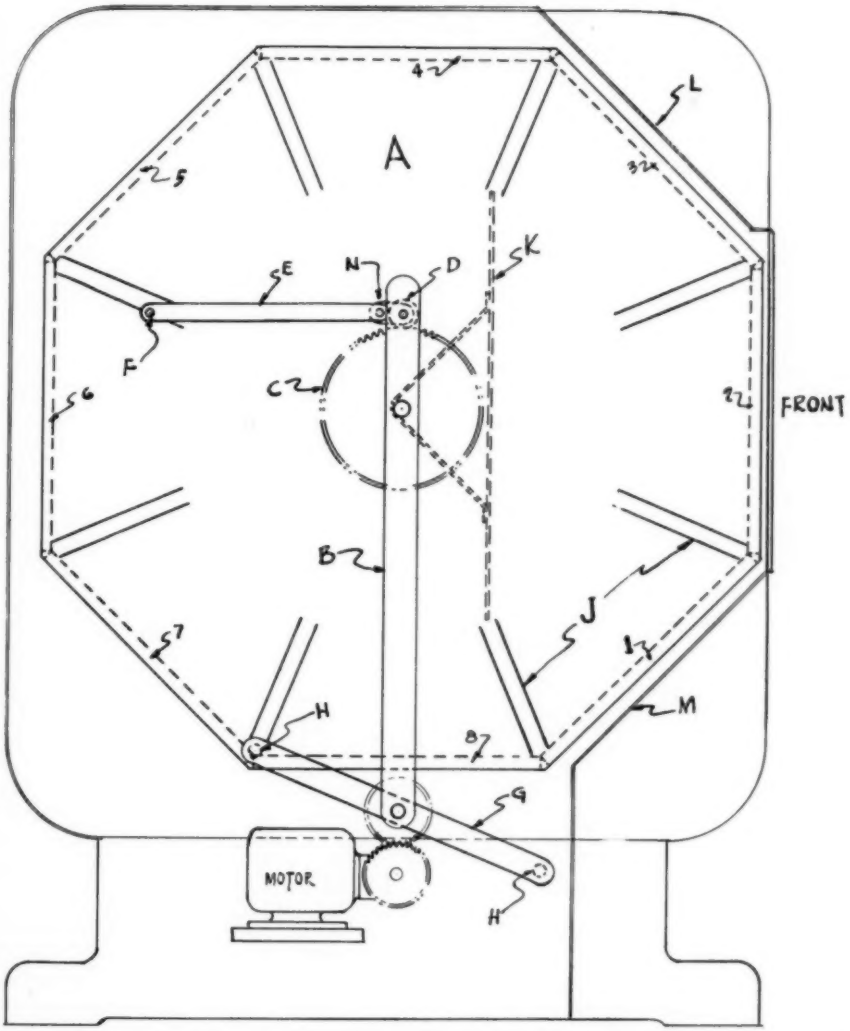


Fig. 2. Schematic drawing of the apparatus with the left-hand side panel removed. On an octagonal drum, A, are mounted eight 14 × 17-inch cassettes (1–8). Single cassettes are inserted through a slot on the right-hand side of the apparatus. The drum is rotated into position for the reception of each cassette by a hand-controlled electrical switch located above the slot. Unloading is accomplished in a similar manner. The drum is supported from below by two arms, which permit it to swing toward and away from the front of the apparatus. When the drum is in the forward position, the cassette is quite close to the front of the apparatus. In this position the exposure is made. As the drum is being rotated to its next position, it swings back, so that the corners of the octagon do not strike the front of the apparatus. This inverted pendulum motion is accomplished by means of the set of gears C and D, the crank N, and the arm E, which is attached to a fixed pivot at F. The drum is rotated by a Geneva drive, consisting of a rotating arm, G, with two driving rollers, H, attached to it. These rollers engage in 8 slots fastened to the side of the drum. The rotating arm is driven by a motor through a suitable drive. Remote controls of the apparatus may be set so that the exposures can be automatically made in rapid succession or with predetermined timed interruptions between exposures. The exposures are set off by means of a switch which is automatically closed an instant before the octagon is rotated to its next position. The films are shielded against x-rays by sheet lead screens, K, L, and M.

auxiliary hand-controlled electrical switch on the side of the apparatus which is used for the manual rotation of the drum, permitting loading and unloading of the apparatus through an opening in the side which measures 4 × 18 inches.

The device measures 2 × 4 × 5 feet and is stationary. The examination is made with the patient in the sitting position. An adjustable stool permits height adjustment. The rotation of the drum and the exposures are automatically synchronized. The exposures can be varied, depending upon what one desires in view of the results of the circulation tests. Many combinations are possible. The remote controls for the apparatus may be set so that exposures can be automatically made in rapid succession or with interruptions between exposures. The exposures are set off by means of a switch which is closed automatically an instant before the octagonal drum is rotated to its next position.

In patients with a normal circulation time, eight exposures can be made within eleven seconds, and the examination may be repeated in another position, should one desire it, or should it be necessary. In those individuals with a prolonged circulation time, two, three, or four exposures may be made in rapid succession at a predetermined time, to obtain opacification of the right heart. This can be followed by a pause after which the apparatus is reactivated to complete its cycle at a predetermined time when the left heart and large vessels should be opacified. The apparatus can be pre-set to make the desired exposures for the right and left heart, and also for the interval of time between the right and left heart exposures. The cycle of eight exposures can be automatically made in the minimum period of eleven seconds and a maximum of twenty-two seconds. With the manual operation of the switches, the maximum automatic control of twenty-two seconds can be exceeded.

When in place, the eight films are shielded from exposure by sheet lead above and below the film, facing the front of the apparatus, and by the suspension of a large non-rotating vertical square of sheet lead mounted on the axis of the drum.

The writer does not use a device for the making of directed exposures. When the exposures are made in rapid succession, and within eleven seconds, they are equally time-spaced, and may occur in any portion of the cardiac cycle. This suffices for the usual requirements. For the study of the physiology of the heart, an electrocardiographic device, originally described by Dr. Schwarzschild, which is quite precise, can be adapted, and the exposures can be pre-set for any portion of the cardiac cycle. With this device, every heart beat cannot be utilized for making the exposures unless the pulse rate is 60 or less. With a pulse rate above 60, every other heart beat can be utilized, so that the exposures will occur in the same portion of the cardiac cycle.

A blood-pressure cuff may also be employed, with a pulse-actuated switch, so that the pulse is the exciting factor for making the exposure. With this cuff, the exposures will be made shortly before the pulse pressure reaches its peak. They will occur within the same portion of the cardiac cycle, but they cannot be pre-set. A fixed lag can be introduced so that the excitation of the tube will occur at a given interval of time after the pulse has reached its peak, which will result in exposures being made either during diastole or at about the beginning of systole. With this lag, however, an additional error enters, because of the modified Valsalva effect. Holding of a deep inspiration results in slowing of the heart rate. Because of the slower heart rate the fixed lag will have a constant relationship to the pulse pressure, a constant time factor in relation to the pulse beat, but not to the cardiac cycle. This means that the serial exposures will be made at a fixed time interval after the pulse beat is picked off from the cuff, and not during the same phase of the electrocardiographic tracing.

Experience gained with this model has prompted plans for an improved model, which will also accommodate eight 14 × 17-inch films. The height of the newer model in its lowest position will measure

39 inches, and it will be capable of being raised to various levels within an upward range of another 21 inches. It will be so constructed that exposures can be made with the patient in either the erect or horizontal position. Lysholm grids[3] are to be mounted in front and on top of the apparatus. This will permit many uses in addition to angiocardiography, namely, aortography, cerebral arteriography, peripheral arteriography, and venography. Adaptors can be substituted for the 14 × 17-inch cassettes, and smaller cassettes may be used, the size depending upon the needs of the individual case. The apparatus can also be used for ventriculography and encephalography. With the newer model, the eight exposures will be made in a minimum of seven instead of eleven seconds.

Unfortunately, neither Dr. Frank Liberson nor his son lived long enough to see the first model completed and in operation. I wish to express my appreciation and thanks to Mrs. Frank Liberson for permitting me to use the completed model, and to Medical Design, 612 Eastern Parkway, Brooklyn, N. Y., the manufacturers, for the installation and servicing of the original model and for consultation and planning of the improved model.

[3] Similar to the Camp screen, recently described.

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SUMARIO

## Aparato para Múltiples Exposiciones Automáticas

El aparato aquí descrito para angiocardiografías permite establecer un ciclo de ocho exposiciones automáticas en un mínimo de once segundos. Se montan ocho películas de 35 × 42.5 cm. en un tambor octagonal rotado por un impulsor "Geneva," que consiste en un brazo rotatorio al cual van unidos dos rodillos impulsores. El brazo rotatorio es movido por un motor, y un dispositivo de contacto atiende a la exposición automática de cada placa apenas se gira al puesto correspondiente. Un conmutador eléctrico manual permite además la rotación a mano del tambor para cargarlo y descargarlo. Por medio de este regulador manual, puede también prolongarse el ciclo de exposiciones más allá del máximo período de veintidós segundos que permite el regulador automático.

En los pacientes con un tiempo prolongado de circulación pueden hacerse en rápida sucesión de dos a cuatro exposiciones en un momento fijado de antemano para obtener opacificación del corazón derecho, y después de una pausa puede reactivarse el aparato para completar el ciclo al opacificarse el corazón izquierdo y los vasos grandes.

Hay en proyecto un modelo perfeccionado que se prestará también para la aortografía, la arteriografía cerebral, la arteriografía periférica y la venografía.

# Effect of X-Rays on Fertility in White Leghorn Male Chickens Treated Before Puberty[1]

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MIRSKAIA AND CREW (1931) and Essenberg and Karrasch (1940) reported the effects of x-rays upon the fertility of the adult cock. The latter workers demonstrated that the minimum dosage required to produce sterility, as determined by histologic studies, was 2,176 r. Essenberg and Zikmund (1938) irradiated chicks from one to twenty-one days of age, killed them within twenty-one days after the last treatment, and made histologic studies of the testes. These workers found that dosages of 300 to 600 r resulted in almost complete degeneration of the seminiferous epithelium, with a tremendous increase in interstitial tissue. They described the seminiferous epithelium as comprising only one layer of cells. It was presumed that these males would have been sterile at maturity.

Even though sections showed only one layer of cells in the tubules and some of these cells were degenerating (the histologic picture typical also of the testes of irradiated sterile adult males), this does not mean necessarily that the mature males would have been sterile. In fact, the testes of normal chicks of this age are in the prepuberal state and likewise contain only one layer of tubular cells. Moreover, the presumption of sterility in adult males as a result of early irradiation assumes that the testes which are damaged in the prepuberal state by x-rays never recover. To the writers' knowledge, no one has studied the effects of x-rays upon fertility and the secondary sexual characters of adult males following irradiation before puberty.

The objectives of the present study were: (1) to determine the minimum dosage of x-rays required to produce sterility in males treated before puberty; (2) to determine whether or not there is any degree of recovery from the treatments; (3) to study the relationship between the histologic picture of the testes and fertility as determined by matings; and (4) to determine the effects of the x-rays upon size of testes, size of comb, and growth.

## MATERIALS AND METHODS

Male White Leghorn chicks four and six weeks of age received varying doses of x-rays over an area of the body including the gonads, adrenals, and parts of the kidneys. The area measured 4 cm. across by 3 cm. longitudinally. The remainder of the bird was shielded with lead. The x-ray tube was operated at 140 kv. and 10 ma. and produced 53 r per minute at a skin-target distance of 43 cm.

Male chicks six weeks of age received the following treatments: (1) 2,800, (2) 2,100, (3) 1,600, and (4) 1,200 r. Each of the chicks received four treatments in approximately equal doses over a two-week period.

Chicks four weeks of age received (1) 8,400 r in six treatments of equal dosages over a three-week period, and (2) 5,600 r in four treatments over a two-week period.

There were 10 males in each of the treated and control groups. Approximately four weeks after the last treatment, 2 to 4 males from each group were killed and the testes were fixed and sectioned for histologic study. The remaining birds were allowed to mature and were mated with females. Approximately one year after

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TABLE I. AVERAGE BODY WEIGHT, COMB SIZE, TESTES SIZE, AND FERTILITY OF IRRADIATED AND CONTROL MALE CHICKS

| Dose in Roentgens (Air) | Body Wt. (lb.) | Body Wt. (lb.) | Body Wt. (lb.) | Comb Size (mm.) | Body Wt. (lb.) | Comb Size (mm.) | Testes Vol. (c.c.) | No. Fertile | No. Sterile | Average Fertility (per cent |
|---|---|---|---|---|---|---|---|---|---|---|
| | 6 Wk. | 10 Wk. | 13 Wk. | | 17 Wk. | | 1 Year of Age | | | |
| 2,800 | 0.596 | 1.12 | 1.84 | 67 × 38 | 2.78 | 84 × 48 | 1.00 | 1 | 5 | 5.9 |
| 2,100 | 0.552 | 1.00 | 1.90 | 68 × 37 | 2.73 | 85 × 47 | 1.93 | 2 | 4 | 20.0 |
| 1,600 | 0.742 | 1.36 | 2.36 | 82 × 47 | 3.50 | 92 × 55 | 3.24 | 3 | 1 | 42.4 |
| 1,200 | 0.650 | 1.16 | 2.17 | 79 × 47 | 3.34 | 90 × 53 | 3.49 | 6 | 0 | 70.7 |
| Control | 0.593 | 1.00 | 2.10 | 77 × 41 | 3.10 | 90 × 49 | 7.53 | 7 | 0 | 62.2 |
| | 5 Wk. | 8 Wk. | 12½ Wk. | | 21 Wk. | | | | | |
| 8,400 | 0.77 | 1.3 | 1.91 | 66 × 41 | 3.36 | 81 × 42 | 0.88 | 0 | 3 | 0 |
| 5,600 | 0.73 | 1.4 | 2.0 | 70 × 39 | 3.50 | 84 × 45 | 0.96 | 0 | 3 | 0 |
| Control | 0.69 | 1.4 | 2.40 | 72 × 41 | 4.36 | 95 × 51 | 11.29 | 5 | 0 | 57.9 |

the treatments, they were killed and the testes were studied histologically. Body weight, comb size, and mating behavior were recorded.

### EFFECTS OF X-RAYS ON COMB SIZE, GROWTH, SIZE OF TESTES, AND FERTILITY

The results of the experiments are summarized in Table I. It is evident that *comb size* was not affected by the treatments, as the observed differences were not significant.

*Weights* of the males receiving up to 2,800 r were recorded at six, ten, thirteen, and seventeen weeks of age. The difference in weights of the treated and control males at seventeen weeks appears to be greater than at earlier ages, but the difference as compared to the control weights is significant only in the case of the males receiving 2,800 and 2,100 r. The more intense treatments, 8,400 and 5,600 r, had a greater effect in decreasing body weight as compared to the weight of the controls at twenty-one weeks of age. This difference was highly significant.

The figures for *testes size* are based upon 3 to 5 birds per group. The volume (in cubic centimeters) of the testes of the irradiated males was in all cases less than that of the controls, and the decrease in volume was in direct proportion to the dosage received. The number of birds involved in the various groups was small, and there was considerable variation within the groups. Therefore, many of the differences observed were not significant statistically. The differences between the volume of the testes of birds receiving 2,800 r and the controls, and of those receiving 8,400 and 5,600 r and the controls, were significant.

Regarding *fertility and mating behavior*, the table shows that most of the males receiving 2,100 and 2,800 r were sterile, whereas most or all of the males receiving 1,600 r or less were fertile. All males receiving 5,600 and 8,400 r were sterile.

The irradiation had no effect upon the mating behavior of the males.

### RELATIONSHIP OF FERTILITY TO HISTOLOGICAL PICTURE

The testes of the males receiving 5,600 and 8,400 r, and of 5 of the 6 males receiving 2,800 r, presented a similar histologic picture, considered typical and indicative of sterility (Fig. 1). This condition in adult males has been described by Mirskaia and Crew (1931), Benoît (1924), and Essenberg and Karrasch (1940), but these workers did not test their males for fertility. All of the tubules were small, and most of them contained only one layer of epithelial cells, some of which were degenerating. Benoît described these cells as Sertoli cells; Essenberg and Karrasch thought both Sertoli and spermatogonial cells were present.

Of the males receiving 2,100 r, 4 were sterile. The testes of 3 of these showed histologically normal-appearing sperm in some of the tubules. All of the tubules near the periphery of the testes presented

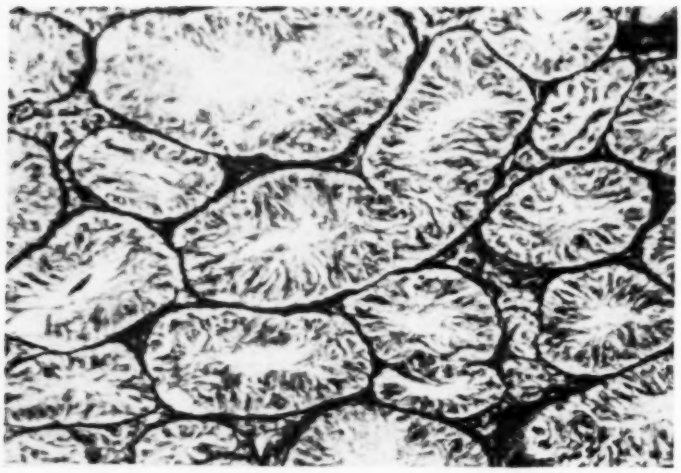

Fig. 1. Testis of adult male which received 5,600 r before puberty. The tubules are smaller than normal and contain one layer of epithelium. This is a typical picture of sterility. Hematoxylin and eosin. × 660

the histologic picture characteristic of sterile tubules, but near the center small areas were found containing tubules with apparently normal sperm, while other tubules contained abnormal spermatozoa. It appears that these males should have been fertile, based upon the histologic picture, provided of course that the vas deferens were not occluded. That it was not occluded is borne out by the fact that these males produced semen upon artificial ejaculation, even though in very small quantities. The ejaculate was watery and chalky. The histologic picture of the testes of one of the fertile males of this group (fertility 25 per cent) was similar to that of the sterile males except that there were more active tubules.

The testes of fertile males from the 1,600 and 1,200 r groups showed little or no effect of the x-rays.

The testes of one fertile male which received 1,200 r presented an interesting histologic picture. Most of the tubules were normal and contained abundant spermatozoa, except for small areas in which the tubules were packed with giant, multinucleated cells (Fig. 2). Essenberg and Zikmund (1938) reported the appearance of similar cells in the ovaries of irradiated female chickens, but this is the first report of their occurrence in male chickens. Such cells have been reported in irradiated mammals (Wigoder 1929).

Of the sections studied from the testes of adult males receiving the different x-ray treatments, those from only one suggested that there was any recovery from the treatment. This bird received 2,800 r and was sterile. Most of the tubules were sterile, except for a few near the center of the testes, which contained abnormal spermatids and spermatozoa. Other sections of the same testes showed a very small area, also near the center of the testes, of normal prepuberal tubules. These tubules were much smaller than the surrounding sterile tubules and appeared to be regenerating. Regeneration following x-ray irradiation has been reported in other species provided that the irradiation was not too intense (see Lipschütz 1924).

Histologic studies were also made of the testes of irradiated males approximately four weeks after the last treatment (males twelve to thirteen weeks old).

Histologic sections of the testes of 9 of the 10 males which received sterilizing dosages (2,150 to 8,400 r) showed the seminiferous epithelium of the tubules to be in

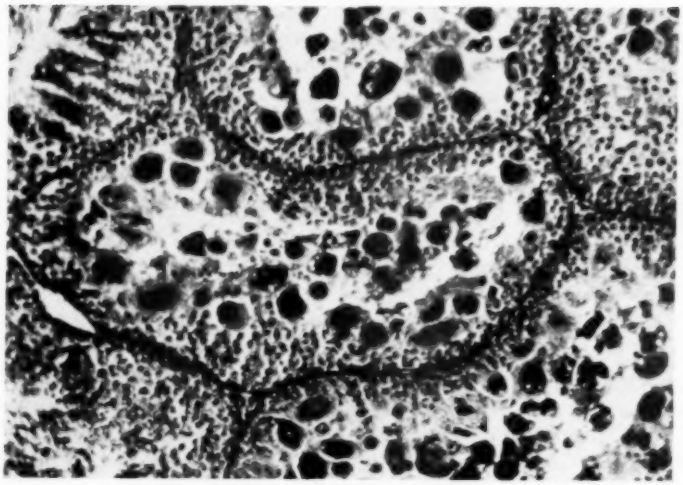

Fig. 2. Testis of adult male which received 1,200 r before puberty, showing presence of multinucleated, giant cells in some of the tubules. This male was fertile, and sections showed normal spermatozoa in many of the tubules. Hematoxylin and eosin. × 740

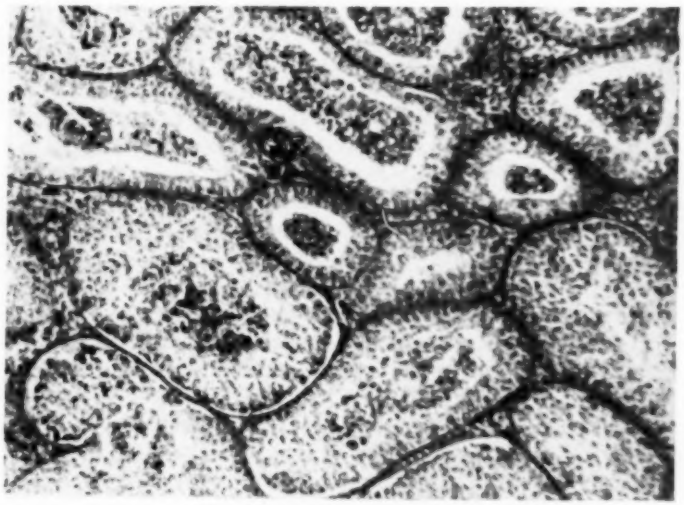

Fig. 3. Testis of male twelve and a half weeks old which received 8,400 r at four weeks of age. Most of the tubules contain several layers of cells, but many of the tubules exhibit degeneration and separation of the cells from the basement membrane and cellular debris in the lumens. Hematoxylin and eosin. ×700

the prepuberal state, *i.e.*, one layer of epithelium. In many of these sections, the epithelium was not unlike that of prepuberal control birds, except that some of the cells bore evidence of degeneration. The testicles of the irradiated males, in most instances, were much smaller than those of the controls, and they contained more interstitial tissue.

It is recalled that the testes of the males were in the prepuberal state when they received the x-rays, and at maturity the tubules of the testes of sterile males contained one layer of epithelium. It might

appear logical to assume that the tubular epithelium of sterile mature males has not changed from its prepuberal state of development; however, the tubules have enlarged, suggesting that in the course of development from the prepuberal state, the tubular epithelium developed several layers, became active, and then degenerated, and was later replaced by an inactive layer of cells, presumably Sertoli cells. The testes of the irradiated males were not studied at varying intervals from twelve weeks of age to maturity to determine definitely the sequence of changes in the seminiferous tubules, but our data suggest that such a process does occur. Figure 3 represents a section of a testis of a male twelve and a half weeks old which received 8,400 r at four weeks of age. This testis was more advanced in development than others studied at this age, but it is possible that, had we studied other testes at fourteen and sixteen weeks, they would have shown a similar histologic picture.

A study of the sections revealed that some of the tubules had several layers of epithelial cells, and some of these cells were undergoing mitosis. Many of the tubules, however, exhibited degeneration and separation of the epithelial cells from the basement layer, with accumulations of cellular debris in the lumen. Some tubules showed the remaining one or two layers of cells.

## DISCUSSION

The results of this study indicate that the minimum sterility dose for most of the males which were irradiated at four to six weeks of age is approximately 2,100 r. Dosages of 1,600 r and less had little effect upon fertility. It is also indicated that, with borderline dosages at least, the histologic state of the testes is not a reliable criterion of functional fertility.

It is recalled that x-rays were administered in series of four to six doses. It is likely that the minimum sterility dose would have been less if the total roentgen units received had been administered in single doses. Essenberg and Zikmund showed that single doses of 300 to 600 r administered to chicks less than four weeks old produced pronounced degenerative changes in the testes within three weeks after irradiation. They presumed that these males would have been sterile at maturity.

Essenberg and Karrasch, who irradiated adult males with dosages up to 2,816 r, found that the tubules of the testes of such males contained only one layer of epithelial cells, which they considered to be Sertoli and spermatogonial cells. They thought that, with very high dosages of x-rays, it might be possible to destroy completely the seminiferous epithelium. If the cells of the remaining layer are Sertoli cells, as Benoît (1924) has considered them to be, then in this study all of the germinal epithelium was destroyed with dosages of 2,800 r. The histologic picture of the testes receiving three to four times the sterilizing dose was not different from that of testes receiving 2,800 r, except that the tubules were smaller.

Essenberg and Zikmund asserted that the growth of irradiated testes is caused not by growth of the seminiferous tubules but by the increase in interstitial tissue. Our studies showed that in normal and irradiated males there appeared to be a decrease in interstitial tissue as the bird reached maturity. Other workers have reported similar observations, but Benoît (1922) demonstrated that in normal males there is an absolute increase in interstitial tissue from puberty to maturity, though there appears to be a decrease because the tubules and the testes have increased tremendously in size.

That the seminiferous tubules may increase in size after having been irradiated before puberty, and the probable changes which occur in the testes from prepuberty to maturity, have been discussed in a preceding section.

## SUMMARY

White Leghorn male chicks, four to six weeks of age, were irradiated with 1,200

to 8,400 r. The area irradiated included the testes, adrenals, and a part of the kidneys.

Most of the males receiving 2,100 to 2,800 r were sterile when mated to females at maturity, whereas with doses of 1,600 r or less most or all were fertile. All males receiving 5,600 and 8,400 r were sterile.

The treatments had no effect upon comb growth and mating behavior.

The testes of the irradiated males were reduced in size, the decrease being proportional to dosage, though some of the observed differences were not significant.

This work shows that the histologic state of the testes is not always a reliable criterion of fertility.

Of the sections studied from the testes of adult males receiving the different treatments, those from only one male suggested that there was any recovery from the treatment.

The probable changes which occur in the testes from prepuberty to maturity following irradiation with x-rays are discussed.

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## SUMARIO

### Efectos de los Rayos X sobre la Fecundidad en los Pollos Tratados Antes de la Pubertad

A fin de determinar el efecto de la irradiación temprana sobre la fertilidad del gallo ya maduro, los A.A. irradiaron pollos blancos de raza Liorna, de cuatro a seis semanas de edad, con rayos X a varias dosis, de 1,200 a 8,400 r. Al cabo de unas cuatro semanas se mataron algunos animales de cado grupo, estudiándose los testículos histológicamente. Al resto se les dejó crecer, estudiándose en tanto sus hábitos copulativos y características sexuales secundarias. Se les mató después, haciéndose estudios histológicos de los testículos. La zona irradiada comprendía los testículos, suprarrenales y parte de los riñones.

La mayor parte de los pollos que recibieron de 2,100 a 2,800 r y todos los que recibieron dosis mayores (5,600 y 8,400 r) eran estériles, en tanto que todos los que recibieron dosis de 1,600 r o menos eran fecundos. No se observó efecto alguno sobre el crecimiento de la cresta o el comportamiento copulativo. Los testículos de los pollos irradiados estaban reducidos en tamaño, siendo la disminución proporcionada a la dosis de rayos, aunque no todas las diferencias observadas fueron significativas. Al describir las observaciones histológicas, dedúcese que el estado histológico de los testículos no constituye siempre una pauta fidedigna de la fertilidad. Sólo en uno de los gallos indicaban los cortes alguna reposición de los efectos de la irradiación.

# EDITORIAL

## Utilization of Radioisotopes in General Radiotherapy

The radiotherapist now has an opportunity to add potent tools to his armamentarium and enrich his consultative service through the intelligent utilization of radioisotopes in clinical practice. Radioiodine and radiophosphorus are being made available to medical groups who can furnish evidence of adequate facilities and proper qualifications for safe handling and correct dispensing of these sources of irradiation. Such qualifications imply a working knowledge of radiation physics, experience in clinical radiotherapy, a knowledge of radiobiology, a good foundation in basic medical science, and clinical familiarity with certain diseases of the blood and thyroid. Application to qualify for utilization of radioisotopes is made on special forms provided by the U. S. Atomic Energy Commission, Paul C. Aebersold, Chief, Isotopes Division, Oak Ridge, Tennessee. Bulletin 1 B-57, U. S. Atomic Energy Commission, "Details of Isotope Procurement," gives full instructions.

Since all required qualifications are rarely fulfilled in a single individual, it is usually necessary to form a Radioisotope Committee. The interested applicants proceed by organization of such a committee under the auspices of some institution or of some medical group. The institution provides facilities and accepts certain attending legal and financial responsibilities in relation to the U. S. Atomic Energy Commission. The committee accepts responsibility for safe handling of materials, assay of dosage, selection of cases for treatment, analysis of results, and general supervision of the program. The committee should consist of three or more members, including a radiotherapist, a competent physicist, and a physician well grounded in physiology, metabolism, and pathology. It is desirable to include an official of the institution and all others directly concerned with the application of radioisotopes to clinical practice and basic research.

The chairman of the committee should be familiar with all aspects of the program and available for consultation to any member of the staff. The radiotherapist will usually qualify for the position of chairman and director of the program unless he be reluctant to accept the responsibility. A disinclination to assume these responsibilities of leadership frequently relegates the radiologist to a position of custodian and technical assistant, wherein opportunity is limited and clinical development is thwarted. The radiologist has an enviable opportunity to correlate irradiation by means of radioisotopes with more conventional irradiation by means of x-rays and radium. The competent radiotherapist must develop a real interest and clinical acumen in regard to all diseases treated by radiation, and particularly in regard to those treated by radioisotopes, as a basis for selection of cases, prescription of dosage, and evaluation of progress.

A dependable, well trained radiation physicist is invaluable, although not absolutely essential, in the management of a radioisotope program. He accepts responsibilities for protection of personnel against irradiation, prevention and detection of contamination of premises, calibration of instruments, assay of radioactivity, and the control and development of instrumentation. In the absence of a specially trained radiation physicist, the radiologist must accept these special responsibilities for safety in handling and accuracy of

dosage. The radiologist is, in general, responsible for clinical consultation, case evaluation, prescription of dosage, and general supervision of the program.

The radiologist embarking in the field of radioisotopes will desire special knowledge of nuclear physics and instrumentation, and a current review of clinical hematology and thyroid physiology. Basic courses in nuclear physics and instrumentation as applied to medicine and biology are currently available. The University of California offers a summer course of three weeks including lectures and laboratory, "Applications of Nuclear Physics to Biological and Medical Sciences." The U. S. Atomic Energy Commission offers a four-week course at the Oak Ridge Institute of Nuclear Studies (Box 117, Oak Ridge, Tenn.). A biological conference including a three-day "Symposium on Radioiodine" was recently arranged by the U. S. Atomic Energy Commission at Brookhaven Laboratory, Upton, Long Island. The radiological societies, the College of Physicians, and other scientific bodies continue to present the progressive developments in this field. Time spent in a good clinic actively engaged in a radioisotope program will provide practical aspects of protection, assay, dosage and clinical management beyond the level attained in most formal presentations. The Radiological Society of North America presented excellent practical demonstrations of instrumentation and clinical utilization of radioisotopes at its 1948 meeting.

HOWARD B. HUNT, M.D.

## IN MEMORIAM

# Eldwin R. Witwer

1890–1948

Dr. Eldwin R. Witwer died at his home in Detroit, Mich., on Nov. 2, 1948, as a result of an illness that had partially incapacitated him for several months.

Dr. Witwer was installed as President of the Radiological Society of North America at the joint meeting of that organization with the American Roentgen Ray Society, in Chicago, in September 1944. This was the climax of his professional career for, although he belonged to numerous scientific and social groups, the Radiological Society of North America was his greatest interest and its presidency was to him a supreme honor. The concluding sentence of his inaugural address stands out as representative of the man, his purpose, and his faith in the fulfillment of that purpose: "If we all accept the responsibility which is ours, our progress cannot be impeded."

No one knew better than Dr. Witwer the obstacles to the scientific, ethical, and economic advance of medicine and of the specialty of radiology. He was in the thick of every fight to prevent exploitation of radiology by quacks, unscrupulous politicians and practitioners, or by the ineptitude of radiologists themselves. His reputation for hard work, faithful service, and militant opposition to things he believed wrong brought him numerous committee assignments from executives of local and national medical societies, in general medicine as well as in radiology.

Dr. Witwer was well fitted for his role in life, having an invaluable foundation in pathology and general medicine for the diagnostic and therapeutic activities of later years. After premedical education at Valparaiso University, he received his medical degree from the Detroit College of Medicine, now Wayne University, in 1914. He then took intensive training in pathology for three years and was appointed Assistant Professor of Pathology in the Detroit College of Medicine. For ten years he was assistant in internal medicine to Dr. C. G. Jennings, an internist of national repute. Attracted to radiology, then a comparatively young specialty, he spent a year in postgraduate study in Cook County Hospital in Chicago, after which he became radiologist to Jennings Hospital in Detroit.

In 1927 Dr. Witwer became associated with Drs. William A. Evans and Lawrence Reynolds in the practice of radiology and joined the staff of the X-ray Department of Harper Hospital, Detroit, which position he held until his death. He was radiologist to Cottage, Marine, Bon Secours, and Children's Hospitals, and was Assistant Professor of Radiology at Wayne University. A tireless worker, he was the life blood of the Detroit Roentgen Ray and Radium Society, controlling its activities as Secretary-Treasurer for twenty-two years, with time out to occupy the presidency. Almost daily he was in session with some committee of the hospitals, the county or state Medical Society, or some civic organization which he served. He was active on committees in the American Roentgen Ray Society, American College of Radiology, of which he was a Chancellor, and of the American Medical Association. His activities in organizing and directing the Michigan Blue Cross Association were of great benefit to its members and their patients. He was honored by membership in the Indiana State Medical Society and the Rocky Mountain Medical Society.

In addition to finding time for scientific papers, presentations for professional groups, and organization work, Dr. Witwer devoted himself extensively to the promotion of good fellowship in the Masonic orders, the Consistory and the Commandery, and to his greatest hobby, farming. He numbered among his friends captains of industry, civic leaders, and the great men of medicine, and it is a tribute to his personality that he could call them by their first names without loss of dignity or undue frivolity. He was married in 1917 to Maude Gibbings, who with a daughter, Mary Helen Witwer, survives him.

It is characteristic of Eldwin R. Witwer that on the day of his death, Election Day, after unmistakable signs of the approaching end had appeared, he insisted on being driven to vote and to transact final business for his Masonic Temple organization! Such an example of devotion to duty is indeed one worthy to be followed.

E. Walter Hall, M.D.

Eldwin R. Witwer
1890–1948

## EASTERN CONFERENCE OF RADIOLOGISTS

The Eastern Conference of Radiologists formerly held annually under the designation Midwinter Conference of Eastern Radiologists, and discontinued after the outbreak of World War II, is to be revived this year with a meeting in Washington, D. C., March 11 and 12, headquarters being at the Hotel Statler. Details as to registration are to be found in the advertising pages of this issue of RADIOLOGY. The following program has been arranged:

*Friday, March 11*

*9:00–10:15 A.M.:* Panel Discussion: Correlation of Electroencephalography, Pneumoencephalography, and Arteriography in Diagnosis of Lesions of the Brain.

1. Radiological Aspects, George M. Wyatt, M.D., Moderator.
2. Neurosurgical Aspects, Arthur A. Morris, M.D.
3. Neurological Aspects, Robert H. Groh, M.D.
4. Neuropathological Aspects, Webb Haymaker, M.D.

*10:30–10:45 A.M.:* Supervoltage Radiation Therapy of Brain Tumors, Maj. Keene M. Wallace, M.C.

*10:45–11:00 A.M.:* Congenital Vascular Anomalies (Phlebectasia), Capt. Acors S. Thompson, M.C.

*11:00–11:15 A.M.:* Diagnostic Problems in the Normal and Pathological Physiology of the Colon, Dr. Willy E. Baensch.

*11:15–11:30 A.M.:* Radiologist's Role in Prevention and Early Diagnosis of Cancer of the Colon, Fred O. Coe, M.D

*11:30–11:45 A.M.:* Differential Diagnosis of Inflammatory, Benign, and Malignant Extrinsic Lesions of Gastro-Intestinal Tract, Henry W. Wood, M.D., with Discussion by Aubrey O. Hampton, M.D.

*11:45–12:00 M:* Colon and Small Bowel Injury Following 1,000 Kv. Roentgen Therapy, Col. Harold I. Amory, M.C., and Irving D. Brick, M.D.

*12:00–12:15 P.M.:* A New Technic for Radium Therapy in Carcinoma of the Bladder, Milton Friedman, M.D., and Lloyd G. Lewis, M.D.

*12:15–12:30 P.M.:* Primary Ureteral Tumor: A Case Report, Wm. M. Clopton, M.D.

*12:30–2:30 P.M.: Luncheon Period*

*2:30–4:30 P.M.* (at National Bureau of Standards): Biological Effects of Chronic Irradiation with Gamma Rays on Laboratory Animals, Staff of National Cancer Institute.

1. Introductory Remarks, Egon Lorenz, Ph.D.
2. Effects on Breeding Behavior of Mice, Margaret K. Deringer, Ph.D.
3. Pathology of Radiation Injury, Allen B. Eschenbrenner, Ph.D.
4. Effects on Life Span, Hematopoiesis, and Carcinogenesis, Egon Lorenz, Ph.D.
   Physical Aspects of X-Ray Protection and Dosage Measurement, Staff of National Bureau of Standards
5. Conditions for Economical Achievement of X-Radiation Protection, Harold O. Wyckoff, Ph.D.
6. Calibration Use of Thimble Chambers up to 1,400 Kv., Lauriston S. Taylor, Ph.D.
7. Conditions for the Proper Utilization of Dosage Meters Particularly in the Low-Energy Range, Frank H. Day, M.S.
8. Inspection of the two new high-voltage laboratories of the Bureau of Standards.

*6:30 P.M.:* Cocktails, in Congressional Ballroom.

*8:00 P.M.:* Banquet, in Presidential Ballroom.

*Saturday, March 12*

*9:00–10:15 A.M.:* Management of "Surgically Incurable" Cancer of the Breast, Moderator, Ralph M. Caulk, M.D.

1. Surgical Aspects, Calvin T. Klopp, M.D.
2. Radiation Therapy, U. V. Wilcox, M.D.
3. Endocrine Aspects, Roy Hertz, M.D.
4. Neurosurgical Aspects, James W. Watts, M.D.

*10:30–10:45 A.M.:* Tissue Distribution of Some Organic Compounds of Isotopes, Chas. F. Geschickter, M.D.

*10:45–11:00 A.M.:* Prenatal Bowing of Tubular Bones; A Presentation of Cases, Francis C. Allman, M.D.

*11:00–11:15 A.M.:* Orbital Foreign Bodies—Criteria for Detection and Discussion of Pfeiffer Method for Localization, A. A. J. Den, M.D.

*11:15–11:30 A.M.:* Epilation in Ringworm of the Scalp, Isidore Lattman, M.D.

*11:30–11:45 A.M.:* Intussusception—Reduced by Barium Enema (Hydrostatic Pressure), Isidore Lattman, M.D., and Gerald H. McAteer, M.D.

*11:45–12:00 M.:* An Analysis of Approximately 7,000 "Positive" Chest Roentgenograms Encountered in a Recent Survey in the District of Columbia, Rollin F. Bunch, M.D., with discussion by Aubrey O. Hampton, M.D.

*12:00–12:15 P.M.:* Value of Chest Roentgenograms as a Routine Part of Cancer Detection Examinations, C. H. Wallman, M.D., with Discussion by Aubrey O. Hampton, M.D.

*12:15–12:30 P.M.:* Clinical Application of Radioisotopes in the Diagnosis and Treatment of Cancer, Murray M. Copeland, M.D.

*12:30–12:45 P.M.:* Results of Radiation Therapy Alone in Adenocarcinoma of the Uterine Cervix and Corpus, George D. Adams, M.D.

### LOS ANGELES RADIOLOGICAL SOCIETY

The First Annual Mid-Winter Radiological Conference sponsored by the Los Angeles Radiological Society will be held in the Biltmore Hotel on Feb. 26 and 27, 1949. All of the courses will be given by prominent Pacific Coast radiologists and on Saturday evening, Feb. 26, following a cocktail party and banquet, Dr. Frederic Templeton of Seattle will speak on "The Differential Diagnosis of Benign and Malignant Gastric Lesions."

Reservations may be made by writing Dr. Donald Laing, 65 N. Madison Ave., Pasadena, Calif. The fee for the entire two-day session is $15.00.

### NORTH CAROLINA RADIOLOGICAL SOCIETY

The North Carolina Radiological Society held its October meeting in conjunction with the Matheson Foundation Medical Lectures in Charlotte, N. C., on Oct. 22, 1948. Features of the meeting were the Film Reading Session, with Dr. Paul C. Swenson, Dr. Robert J. Reeves, Dr. J. P. Rousseau, and Dr. Eugene P. Pendergrass as guests, and an address on "Problems in the Diagnosis of the Diseases of the Large Intestine," by Dr. Paul C. Swenson, Professor of Radiology, Jefferson Medical School.

### SEVENTH INTERNATIONAL CONGRESS ON RHEUMATIC DISEASES

The Seventh International Congress on Rheumatic Diseases will be held in New York City, May 30 through June 3, 1949, under the sponsorship of the International League against Rheumatism. Hosts will be the officers and the 400 members of the American Rheumatism Association, assisted by the New York Rheumatism Association. Dr. Philip Hench, of the Mayo Clinic, is Chairman of the American Committee on Arrangements. Dr. W. Edward Boland, of Los Angeles, is Chairman of the Program Committee.

### HONORS FOR DR. CASE

During a recent visit to Mexico and Guatemala, Dr. James Case was signally honored by the Mexican Government, which bestowed upon him the medal of "Mérito Militar," in recognition of his contributions to radiology in Mexico and the help which he has rendered Mexican physicians, especially those of the military establishment, during the past thirty years.

## Books Received

Books received are acknowledged under this heading, and such notice may be regarded as recognition of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

RADON: ITS TECHNIQUE AND USE. By W. A. JENNINGS, B.Sc., A. INST. P., Physicist to the Royal Northern Hospital and Prince of Wales's General Hospital Joint Radiotherapy Centre, and S. RUSS, C.B.E., D.Sc., F. INST. P., formerly Physicist to the Middlesex Hospital, London. A volume of 222 pages, with numerous illustrations. Published for The Middlesex Hospital Press by John Murray, Albemarle St., London, W.1., 1948. Price 18s. net.

EDUCATION FOR PROFESSIONAL RESPONSIBILITY. A Report of the Proceedings of the Inter-Professions Conference on Education for Professional Responsibility, Buck Hill Falls, Pennsylvania, April 12–14, 1948. A volume of 207 pages. Published by the Carnegie Press, Carnegie Institute of Technology, Pittsburgh.

PHYSICIANS' FEDERAL INCOME TAX GUIDE. FOR THE PREPARATION OF 1948 RETURNS AND 1949 ESTIMATES. By HUGH J. CAMPBELL and JAMES B. LIBERMAN. 1948–49 Edition. A volume of 96 pages. Published by Doniger & Raughley, Inc., Great Neck, N. Y. Price $2.50.

THE MEDICAL ANNUAL. A YEAR BOOK OF TREATMENT AND PRACTITIONER'S INDEX. Editors: SIR HENRY TIDY, K.B.E., M.A., M.D. (Oxon), F.R.C.P., and A. RENDLE SHORT, M.D., B.S., B.Sc., F.R.C.S. A volume of 414 pages. Published by John Wright & Sons, Bristol, and Simpkin Marshall (1941) Ltd., London, 1948.

## Book Reviews

THE 1948 YEAR BOOK OF RADIOLOGY. Diagnosis, edited by FRED JENNER HODGES, M.D., Professor and Chairman, Department of Roentgenology, University of Michigan; Associate Editor, JOHN FLOYD HOLT, M.D., Associate Professor, Department of Roentgenology, University of Michigan. Therapeutics, edited by IRA I. KAPLAN, M.D., F.A.C.R., Director, Radiation Therapy Department, Bellevue Hospital, New York City; Clinical Professor of Radiology, New York University Medical College; Attending Radiation Therapist, Beth David Hospital; Associate Editor, SIDNEY RUBENFELD, M.D, F.A.C.R., Visiting Radiation Therapist, Bellevue Hospital, New York City; Associate Clinical Professor of Radiology, New York University Medical College. A volume of 742 pages, with 393 illustrations. Published by the Year Book Publishers, Inc., Chicago. Price $6.50.

The 1948 Year Book of Radiology continues to offer within the scope of a few hundred pages the essence of the recent radiological literature. The

section on diagnosis appears for the first time under the editorship of Dr. Fred Jenner Hodges and Dr. John Floyd Holt, of the University of Michigan. Their wide experience and excellent judgment are reflected in the choice and arrangement of their material and their occasional editorial comments. As is stated in the introduction, "No single contribution has dominated the stage. On the other hand, the articles here abstracted bear testimony to the fact that diagnostic roentgenology has forged steadily ahead, entrenching itself more firmly than ever as an extremely important phase of modern medicine."

The section on therapy continues under the editorship of Dr. Ira I. Kaplan and Dr. Sidney Rubenfeld. The Introduction to this section includes, in addition to a summary of the outstanding contributions to the literature, notes on the meetings of the national societies and tributes to those men whose recent deaths call to mind with renewed emphasis their contributions to radiology. The material from the literature is considered, as in past years, under the various specialties. The section on Radiation in Gynecology occupies the greatest number of pages, with comprehensive abstracts of the various articles that have appeared in the course of the year on improved technics for cervical and endometrial carcinoma.

The current Year Book, with its careful selection of material, good reproductions of illustrations, and enlightening comment sets a standard of excellence that the recently launched abstract journals will do well to consider.

ROENTGEN STUDIES OF THE LUNGS AND HEART. A SERIES OF LECTURES DELIVERED AT THE CENTER FOR CONTINUATION STUDY, UNIVERSITY OF MINNESOTA. By NILS WESTERMARK, M.D., Director, Department of Radiology, St. Göran's Hospital, Stockholm, Sweden. A volume of 216 pages, with 98 illustrations. Edited by LEO G. RIGLER, M.D., Professor of Radiology, University of Minnesota. Published by the University of Minnesota Press, Minneapolis; Oxford University Press, London, 1948. Price $7.00.

In 1946 and 1947, Dr. Nils Westermark of Stockholm delivered at the Center for Continuation Study, University of Minnesota, a series of lectures on thoracic roentgenology. Dr. Leo Rigler, Professor of Roentgenology at the University, has edited them and the University press has published them so that they may be available to a much larger group than that attending the course. The book does not pretend to constitute a systematic treatise on all the diseases of the thorax. It is rather a series of studies in which the author summarizes many of his own contributions to roentgen diagnosis.

To choose a few points of special interest, one may mention the method of roentgenography of the lungs at selected levels of intra-alveolar pressure, with a description of the changes to be observed; the correlation of the roentgen findings in tuberculosis with the demonstration of the gross pathology; the author's studies on bronchogenic carcinoma, and the chapters on pulmonary embolism and roentgen cinematography of the circulation after the introduction of a contrast medium, this last presented in part in RADIOLOGY for June 1948.

This book will be of particular interest to those who wish a different approach to certain chest lesions. It is abundantly illustrated with roentgenograms, photographs, and line drawings. The material is thought-provoking and stimulating. To quote the editor, "The judgment of time and further investigation will determine the significance of these contributions."

THE DIGESTIVE TRACT IN ROENTGENOLOGY. By JACOB BUCKSTEIN, M.D., Assistant Professor of Clinical Medicine, Cornell University Medical College; Visiting Roentgenologist (Alimentary Tract Division), Bellevue Hospital, New York City; Attending Gastro-enterologist, Beth David Hospital, New York City; Consultant in Gastro-enterology, Central Islip State Hospital, New York; Formerly Consultant in Gastro-enterology to the U. S. Public Health Service and the U. S. Veterans Bureau. A volume of 890 pages, with 1030 illustrations in 659 figures. Published by J. B. Lippincott Company, Philadelphia, 1948. Price $16.00.

In this new book, based on the author's extensive observations at Bellevue Hospital and in private practice, we have an authoritative work which will prove of great value to all those who are interested in the roentgenologic aspects of gastro-intestinal diagnosis.

The contents are grouped in eight main sections, dealing, respectively, with (1) the hypopharynx and esophagus; (2) the stomach; (3) the duodenum; (4) the small intestine; (5) the large intestine; (6) herniation and eventration of the diaphragm; (7) the gallbladder and bile ducts; (8) the spleen, liver, and pancreas. Each of these sections is further subdivided into chapters on individual lesions. Brief descriptions of the anatomy and physiology of the various parts of the alimentary tract are included, but the details of clinical examination, which are adequately covered in other texts, are largely omitted here. A useful feature is the integration with the descriptive material of numerous case histories, illustrated by films well chosen and excellently reproduced.

A bibliography accompanies each chapter, and comprehensive indexes of authors and subjects are included.

MALIGNANT DISEASE AND ITS TREATMENT BY RADIUM. By SIR STANFORD CADE, K.B.E., C.B., F.R.C.S., M.R.C.P., Surgeon, Westminster

Hospital, Mount Vernon Hospital and Radium Institute; Lecturer in Surgery, Westminster Hospital Medical School and formerly Examiner in Surgery, University of London; Member of the Court of Examiners, late Hunterian Professor and Arris and Gale Lecturer, Royal College of Surgeons of England; Member of the National Radium Commission and Trust; Consultant in Surgery to the Royal Air Force. With a foreword by SIR ERNEST ROCK CARLING, F.R.C.P., F.R.C.S., F.F.R., Consulting Surgeon and Vice-President, Westminster Hospital. Second Edition, Volume I. A volume of 384 pages, with 161 illustrations and 36 tables. Published by Williams & Wilkins Co., Baltimore, 1948. Price $12.50.

Shortly after the publication, in 1940, of Sir Stanford Cade's "Malignant Disease and Its Treatment by Radium," most of the edition, as well as the plates from which it was printed, were destroyed by enemy bombing action. Happily, after the lapse of some years, a second edition is appearing. This will comprise four volumes, replacing the single rather bulky tome in which the work originally appeared.

Volume I, which has just been received, covers the radioactivity of radium and its biological effects. Part I, on "Radioactivity," opens with an introductory chapter on the relation of radium therapy to cancer, both for palliation and cure. The physics of radium is discussed in succeeding chapters, and matters of technic and dosage determination are gone into in some detail. The chapter on dosimetry is the work of Dr. C. W. Wilson, who has included a number of depth dosage charts. Dr. L. H. Gray contributes a chapter on the measurement of radium plaques, and Prof. H. T. Flint one on radium teletherapy, with a description of teletherapy units of several types.

Part II is devoted to the biological effects of radiation and comprises the larger portion of the book. One chapter takes up the subject of radiosensitivity as observed under varying conditions. The mode of action of radiation, both direct and indirect, is discussed, and the known effects are described. An important chapter records the effects of radiation on the normal tissues as shown by experimental work. Another describes similar effects on malignant tumors and considers the sensitivity of various cell types. Tissue culture and an appraisal of its value in radiological research form the subject of a chapter by Dr. F. G. Spear. A discussion of protection concludes the volume.

The author and his collaborators have handled the physical and biologic aspects of radium therapy clearly and simply, with a minimum of mathematical formulae, and we look forward with anticipation to the remaining volumes, which will cover the natural history and treatment of malignant disease as it affects the various parts of the human body.

The book is well illustrated and attractively designed. A bibliography accompanies each chapter.

THE TREATMENT OF MALIGNANT DISEASE BY RADIUM AND X-RAYS, BEING A PRACTICE OF RADIOTHERAPY. By RALSTON PATERSON, M.C., M.D., F.R.C.S.E., D.M.R.E., F.F.R., Christie Hospital and Holt Radium Institute, Manchester. A volume of 622 pages, with numerous figures, tables, and charts. Published by Butler and Tanner, Ltd., Frome and London; The Williams & Wilkins Co., Baltimore, 1948. Price $11.00.

This compact and highly readable text, presenting the principles and practice of the Holt Radium Institute of Manchester, may be considered a manual of radiotherapy. It abounds with technical data on dosage determination, tumor localization, beam direction, construction of radium applicators and, in general, on the choice and planning of treatment.

Opening chapters present a critical review of basic principles. Following a discussion of "armamentarium" (x-ray therapy is limited to the use of machines within the 250-kv. range), the author develops his concept of "prescription" in radiotherapy. Emphasis is placed on tumor dose and on its measurement by isodose charting; readers will be interested in the criticism of "air-dose." Methods of obtaining and calculating uniformity of tumor dose in multiple-field therapy are painstakingly described and well illustrated. Familiar rules of radium distribution are reiterated and radium dosage charts provided. Laboratory details of mask and mould construction are included, with accompanying diagrams and photographs.

Chapters on the therapy of specific tumors cover pathology and clinical features in brief, carefully explain treatment policy, and outline in detail the methods employed. Positioning, field and dose distribution, mould forms, etc., are illustrated. Calculations of sample prescriptions are an outstanding feature of this as well as of the preceding section. Notes on nursing after-care are added.

The remainder of the work concerns itself with teleradium units, departmental organization, protection of personnel, a survey of biological effects, and the newer agents in radiotherapy.

The text is carefully indexed for convenient use. The book is printed on good paper and is attractively bound. It will be of great value to radiologists who are interested in the treatment of cancer and allied diseases by radiation.

DIE BEIDERSEITIGE NIERENSTEINKRANKHEIT [BILATERAL KIDNEY STONE DISEASE]. By DR. BERTRAND BIBUS. BAND III, Wiener Beiträge zur Urologie, edited by DR. RICHARD ÜBELHÖR. A volume of 170 pages, with 40 illustrations. Published by Wilhelm Maudrich, Wien, 1948. Distributed by Grune & Stratton, Inc., New York. Price $6.00.

Volume III of the Wiener Beiträge zur Urologie is a treatise on bilateral kidney stone disease. Of all

cases of kidney stones, bilateral calculi were found in 10 per cent in the Urological Department of the Krankenhaus der Stadt Wien. The figures of the Mayo Clinic are only 1 per cent, while the average taken from the literature is between 9 and 15 per cent.

The general causes for stone formation are discussed in detail, with due cognizance of modern American and European theories. The clinical and roentgenological features of the disease are adequately described, though it may seem that the value of intravenous urography has not been adequately emphasized according to American standards.

The consideration of medical and surgical therapy comprises the greatest part of the treatise. Surprising is the importance attached to balneotherapy, apparently still practised in some of the European spas. The pages on chemical therapy of urinary infection do not mention some of the modern sulfa drugs or streptomycin, nor is there a discussion of dosage of any of the newer urinary antiseptics, probably because of inadequate supplies of these in present-day Vienna. The difficulties of surgical procedures in the presence of bilateral stones are emphasized. A somewhat more conservative type of surgery is being practised, compared with the previous decades. Very large stones, filling the kidney pelves and calices are seldom an indication for surgery. Stones due to severe generalized diseases call for operation only in desperate circumstances. Removal of stones of both kidneys by a single operation is considered too dangerous and seldom advisable. If possible, both kidneys should be operated upon with an interval between the two procedures, the better functioning kidney being treated first. Nephrostomies are at times necessary when there is impending uremia.

This book is to be recommended for an adequate review of bilateral kidney stone disease, including the non-German literature, and for the definite attitude of the Vienna School on this problem.

# RADIOLOGICAL SOCIETIES: SECRETARIES AND MEETING DATES

*Editor's Note:* Secretaries of state and local radiological societies are requested to co-operate in keeping this section up-to-date by notifying the editor promptly of changes in officers and meeting dates.

## UNITED STATES

RADIOLOGICAL SOCIETY OF NORTH AMERICA. *Secretary-Treasurer*, Donald S. Childs, M.D., 713 E. Genesee St., Syracuse 2, N. Y.

AMERICAN RADIUM SOCIETY. *Secretary*, Hugh F. Hare, M.D., 605 Commonwealth Ave., Boston 15, Mass.

AMERICAN ROENTGEN RAY SOCIETY. *Secretary*, Harold Dabney Kerr, M.D., Iowa City, Iowa.

AMERICAN COLLEGE OF RADIOLOGY. *Secretary*, William C. Stronach, 20 N. Wacker Dr., Chicago 6, Ill.

SECTION ON RADIOLOGY, A. M. A. *Secretary*, U. V. Portmann, M.D., Cleveland Clinic, Cleveland 6, Ohio.

### Alabama

ALABAMA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, W. D. Anderson, M.D., 2501 6th St., Tuscaloosa.

### Arkansas

ARKANSAS RADIOLOGICAL SOCIETY. *Secretary*, Fred Hames, M.D., Pine Bluff. Meets every three months and at meeting of State Medical Society.

### California

CALIFORNIA MEDICAL ASSOCIATION, SECTION ON RADIOLOGY. *Secretary*, Sydney F. Thomas, M.D., Palo Alto Clinic, Palo Alto.

LOS ANGELES RADIOLOGICAL SOCIETY. *Secretary*, Moris Horwitz, M.D., 2009 Wilshire Blvd., Los Angeles 5. Meets second Wednesday of each month at County Society Bldg.

NORTHERN CALIFORNIA RADIOLOGICAL CLUB. *Secretary*, Charles E. Grayson, M.D., Medico-Dental Bldg., Sacramento 14. Meets at dinner last Monday of September, November, January, March, and May.

PACIFIC ROENTGEN SOCIETY. *Secretary*, L. Henry Garland, M.D., 450 Sutter St., San Francisco 8. Meets annually with State Medical Association.

SAN DIEGO ROENTGEN SOCIETY. *Secretary*, R. F. Niehaus, M.D., 1831 Fourth Ave., San Diego. Meets first Wednesday of each month.

X-RAY STUDY CLUB OF SAN FRANCISCO. *Secretary*, Ivan J. Miller, M.D., 49 Fourth St. Meets monthly on the third Thursday at 7:45 P.M., January to June at Lane Hall, Stanford University Hospital, and July to December at Langley Porter Clinic, University of California Hospital.

### Colorado

COLORADO RADIOLOGICAL SOCIETY. *Secretary*, Mark S. Donovan, M.D., 306 Majestic Bldg., Denver 2. Meets third Friday of each month, at the Colorado School of Medicine and Hospitals.

### Connecticut

CONNECTICUT STATE MEDICAL SOCIETY, SECTION ON RADIOLOGY. *Secretary*, Robert M. Lowman, M.D., Grace-New Haven Hospital, Grace Unit, New Haven. Meetings bimonthly, second Thursday.

CONNECTICUT VALLEY RADIOLOGIC SOCIETY. *Secretary*, Ellwood W. Godfrey, M.D., 1676 Boulevard, W. Hartford. Meets second Friday of October and April.

### District of Columbia

RADIOLOGICAL SECTION, DISTRICT OF COLUMBIA MEDICAL SOCIETY. *Secretary*, Alfred A. J. Den, M.D., 1801 K St., N.W., Washington 6. Meets third Thursday, January, March, May, and October, at 8:00 P.M., in Medical Society Auditorium.

### Florida

FLORIDA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, F. K. Hurt, M.D., Riverside Hospital, Jacksonville. Meets in April and in November.

### Georgia

GEORGIA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Robert Drane, M.D., De Renne Apartments, Savannah. Meets in November and at the annual meeting of State Medical Association.

### Illinois

CHICAGO ROENTGEN SOCIETY. *Secretary*, T. J. Wachowski, M.D., 310 Ellis Ave., Wheaton. Meets at the Palmer House, second Thursday of October, November, January, February, March, and April, at 8:00 P.M.

ILLINOIS RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, William DeHollander, M.D., St. Johns' Hospital, Springfield. Meetings quarterly as announced.

ILLINOIS STATE MEDICAL SOCIETY, SECTION ON RADIOLOGY. *Secretary*, Harold L. Shinall, M.D., St. Joseph's Hospital, Bloomington.

### Indiana

INDIANA ROENTGEN SOCIETY. *Secretary-Treasurer*, William M. Loehr, M.D., 712 Hume-Mansur Bldg., Indianapolis 4. Annual meeting in May.

### Iowa

IOWA X-RAY CLUB. *Secretary*, Arthur W. Erskine, M.D., 326 Higley Building, Cedar Rapids. Meets during annual session of State Medical Society.

### Kansas

KANSAS RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Anthony F. Rossitto, M.D., Wichita Hospital, Wichita. Meets annually with State Medical Society.

### Kentucky

KENTUCKY RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Sydney E. Johnson, M.D., 101 W. Chestnut St., Louisville.

LOUISVILLE RADIOLOGICAL SOCIETY, *Secretary-Treasurer*, Everett L. Pirkey, Louisville General Hospital, Louisville 2. Meets second Friday of each month at Louisville General Hospital.

**Louisiana**

LOUISIANA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Johnson R. Anderson, M.D., No. Louisiana Sanitarium, Shreveport. Meets with State Medical Society.

ORLEANS PARISH RADIOLOGICAL SOCIETY. *Secretary*, Joseph V. Schlosser, M.D., Charity Hospital of Louisiana, New Orleans 13. Meets first Tuesday of each month.

SHREVEPORT RADIOLOGICAL CLUB. *Secretary*, Oscar O. Jones, M.D., 2622 Greenwood Road. Meets monthly September to May, third Wednesday.

**Maryland**

BALTIMORE CITY MEDICAL SOCIETY, RADIOLOGICAL SECTION. *Secretary*, J. Howard Franz, M.D., 1127 St. Paul St., Baltimore 2.

**Michigan**

DETROIT X-RAY AND RADIUM SOCIETY. *Secretary-Treasurer*, George Belanger, M.D., Harper Hospital, Detroit 1. Meetings first Thursday, October to May, at Wayne County Medical Society club rooms.

MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS. *Secretary-Treasurer*, R. B. MacDuff, M.D., 220 Genesee Bank Building, Flint 3.

**Minnesota**

MINNESOTA RADIOLOGICAL SOCIETY. *Secretary*, C. N. Borman, M.D., 802 Medical Arts Bldg., Minneapolis 2. Meets in Spring and Fall.

**Missouri**

RADIOLOGICAL SOCIETY OF GREATER KANSAS CITY. *Secretary*, Wm. M. Kitchen, M.D., 1010 Rialto Building, Kansas City 6, Mo. Meetings last Friday of each month.

ST. LOUIS SOCIETY OF RADIOLOGISTS. *Secretary*, Edwin C. Ernst, M.D., 100 Beaumont Medical Bldg. Meets on fourth Wednesday, October to May.

**Nebraska**

NEBRASKA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Ralph C. Moore, M.D., Nebraska Methodist Hospital, Omaha 3. Meets third Wednesday of each month at 6 P.M. in Omaha or Lincoln.

**New England**

NEW ENGLAND ROENTGEN RAY SOCIETY. *Secretary-Treasurer*, George Levene, M.D., Massachusetts Memorial Hospitals, Boston. Meets monthly on third Friday at Boston Medical Library.

**New Hampshire**

NEW HAMPSHIRE ROENTGEN SOCIETY. *Secretary-Treasurer*, Albert C. Johnston, M.D., Elliot Community Hospital, Keene. Meetings quarterly in Concord.

**New Jersey**

RADIOLOGICAL SOCIETY OF NEW JERSEY. *Secretary*, Raphael Pomeranz, M.D., 31 Lincoln Park, Newark 2. Meetings at Atlantic City at time of State Medical Society and midwinter in Newark.

**New York**

ASSOCIATED RADIOLOGISTS OF NEW YORK, INC. *Secretary*, William J. Francis, M.D., East Rockaway.

BROOKLYN ROENTGEN RAY SOCIETY. *Secretary-Treasurer*, Abraham H. Levy, M.D., 1354 Carroll St., Bklyn. 13. Meets fourth Tuesday of each month, October to April.

BUFFALO RADIOLOGICAL SOCIETY. *Secretary-Treasurer*. Mario C. Gian, M.D., 610 Niagara St., Buffalo 1. Meetings second Monday, October to May.

CENTRAL NEW YORK ROENTGEN SOCIETY. *Secretary-Treasurer*, Dwight V. Needham, M.D., 608 E. Genesee St., Syracuse 10. Meetings in January, May, and October.

LONG ISLAND RADIOLOGICAL SOCIETY. *Secretary*, Marcus Wiener, M.D., 1430 48th St., Brooklyn 19. Meetings fourth Thursday evening, October to May, at 8:45 P.M., in Kings County Medical Bldg.

NEW YORK ROENTGEN SOCIETY. *Secretary*, Wm. Snow, M.D., 941 Park Ave., New York 28.

QUEENS ROENTGEN RAY SOCIETY. *Secretary*, Jacob E. Goldstein, M.D., 88-29 163rd St., Jamaica 3. Meets fourth Monday of each month.

ROCHESTER ROENTGEN-RAY SOCIETY. *Secretary*, Murray P. George, M.D., 260 Crittenden Blvd. Rochester 7. Meets at Strong Memorial Hospital, third Monday, September through May.

**North Carolina**

RADIOLOGICAL SOCIETY OF NORTH CAROLINA. *Secretary-Treasurer*, James E. Hemphill, M.D., Professional Bldg., Charlotte 2. Meets in May and October.

**North Dakota**

NORTH DAKOTA RADIOLOGICAL SOCIETY. *Secretary*, Charles Heilman, M.D., 1338 Second St., N., Fargo.

**Ohio**

OHIO STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Carroll Dundon, M.D., 2065 Adelbert Road, Cleveland 6. Next meeting at annual meeting of the State Medical Association.

CENTRAL OHIO RADIOLOGICAL SOCIETY. *Secretary*, Paul D. Meyer, M.D., Grant Hospital, Columbus. Meets second Thursday, October, December, February, April, and June, 6:30 P.M., Seneca Hotel, Columbus.

CINCINNATI RADIOLOGICAL SOCIETY. *Secretary*, Eugene L. Saenger, M.D., 735 Doctors Bldg., Cincinnati 2. Meets last Monday, September to May.

CLEVELAND RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, George L. Sackett, M.D., 10515 Carnegie Ave., Cleveland 6. Meetings at 6:30 P.M. on fourth Monday, October to April, inclusive.

### Oklahoma

OKLAHOMA STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, W. E. Brown, M.D., 21st and Xanthus, Tulsa 4. Meets in October, January, and May.

### Oregon

OREGON RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Boyd Isenhart, M.D., 214 Medical-Dental Bldg., Portland 5. Meets monthly, on the second Wednesday, at 8:00 P.M., in the library of the University of Oregon Medical School.

### Pacific Northwest

PACIFIC NORTHWEST RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Sydney J. Hawley, M.D., 1320 Madison St., Seattle 4, Wash. Meets annually in May.

### Pennsylvania

PENNSYLVANIA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, James M. Converse, M.D., 416 Pine St., Williamsport 8. Meets annually.

PHILADELPHIA ROENTGEN RAY SOCIETY. *Secretary*, Arthur Finkelstein, M.D., Graduate Hospital, Philadelphia. Meets first Thursday of each month at 8:00 P.M., from October to May, in Thomson Hall, College of Physicians, 21 S. 22d St.

PITTSBURGH ROENTGEN SOCIETY. *Secretary-Treasurer*, R. P. Meader, M.D., 4002 Jenkins Arcade, Pittsburgh 22. Meets second Wednesday of each month at 6:30 P.M., October to June.

### Rocky Mountain States

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Maurice D. Frazer, M.D., Lincoln Clinic, Lincoln, Nebr.

### South Carolina

SOUTH CAROLINA X-RAY SOCIETY. *Secretary-Treasurer*, Robert B. Taft, M.D., 103 Rutledge Ave., Charleston 16.

### Tennessee

MEMPHIS ROENTGEN CLUB. Meetings second Tuesday of each month at University Center.

TENNESSEE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, J. Marsh Frére, M.D., 707 Walnut St., Chattanooga. Meets annually with State Medical Society in April.

### Texas

DALLAS-FORT WORTH ROENTGEN STUDY CLUB. *Secretary*, X. R. Hyde, M.D., Medical Arts Bldg., Fort Worth 2. Meetings on third Monday of each month in Dallas in the odd months and in Fort Worth in the even months.

HOUSTON X-RAY CLUB. *Secretary*, Curtis H. Burge, M.D., 3020 San Jacinto, Houston 4. Meetings fourth Monday of each month.

TEXAS RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, R. P. O'Bannon, M.D., 650 Fifth Ave., Fort Worth 4.

### Utah

UTAH STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Angus K. Wilson, M.D., 343 S. Main St., Salt Lake City. Meets third Wednesday, January, March, May, September, November.

### Virginia

VIRGINIA RADIOLOGICAL SOCIETY. *Secretary*, P. B. Parsons, M.D., Norfolk General Hospital, Norfolk 7.

### Washington

WASHINGTON STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Homer V. Hartzell, M.D., 310 Stimson Bldg., Seattle 1. Meetings fourth Monday, October through May, at College Club, Seattle.

### Wisconsin

MILWAUKEE ROENTGEN RAY SOCIETY. *Secretary-Treasurer*, Theodore J. Pfeffer, M.D., 839 N. Marshall St., Milwaukee 2. Meets monthly on second Monday at the University Club.

RADIOLOGICAL SECTION OF THE WISCONSIN STATE MEDICAL SOCIETY. *Secretary*, S. R. Beatty, M.D., 185 Hazel St., Oshkosh. Two-day meeting in May and one-day with State Medical Society, September.

UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE. Meets first and third Thursdays 4 P.M., September to May, Service Memorial Institute, Madison 6.

### Puerto Rico

ASOCIACIÓN PUERTORRIQUEÑA DE RADIOLOGÍA. *Secretary*, Jesús Rivera Otero, M.D., Box 3542, Santurce, Puerto Rico.

## CANADA

CANADIAN ASSOCIATION OF RADIOLOGISTS. *Honorary Secretary-Treasurer*, E. M. Crawford, M.D., 2100 Marlowe Ave., Montreal 28, Quebec. Meetings in January and June.

LA SOCIÉTÉ CANADIENNE-FRANÇAISE D'ELECTROLOGIE ET DE RADIOLOGIE MÉDICALES. *General Secretary*, Origéne Dufresne, M.D., Institut du Radium, Montreal. Meets third Saturday each month.

## CUBA

SOCIEDAD DE RADIOLOGÍA Y FISIOTERAPIA DE CUBA. Offices in Hospital Mercedes, Havana. Meets monthly.

## MEXICO

SOCIEDAD MEXICANA DE RADIOLOGÍA Y FISIOTERAPIA, *General Secretary*, Dr. Dionisio Pérez Cosío Marsella 11, México, D. F. Meetings first Monday of each month.

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# ROENTGEN DIAGNOSIS

## THE HEAD AND NECK

**Observations upon Patients with Penetrating Wounds Involving the Cerebellum.** John E. Webster, R. C. Schneider, and J. E. Lofstrom. Ann. Surg. **127:** 327–337, February 1948.

Of 300 penetrating cranial wounds seen in a General Hospital in World War II, 10, or 3 per cent, involved the cerebellum. In 3 of these cases the wound of entrance was in the neck and the cerebellar injury was initially overlooked. In this connection it is pointed out that even minor appearing wounds of the posterior neck region may be associated with intracranial damage.

Because of the possibility of early and serious complications, wounds of the cerebellum demand prompt treatment. In the case of war wounds this means operation in the Evacuation Hospital, usually by a unilateral cerebellar incision, under endotracheal anesthesia. Adequate roentgen studies are essential in the preoperative estimation of the location and degree of bone injury and of the probable track of the metallic fragment. The diagnosis of a suboccipital injury may depend upon the technic employed. Views of the base in a mento-vertical and an occipito-vertical position were found to be useful.

Large metallic fragments should be removed, if accessible, at the least indication that an inflammatory complication exists. A case is reported in which such a complication occurred following failure to remove the foreign body when the patient was first treated in the Evacuation Hospital. Other complications are illustrated by brief case histories. These include acute subdural cerebellar hematoma; an intracerebellar clot in a patient in whom the injury to the cerebellum had been overlooked; a cerebellar abscess, with death from tetanus; severe basilar damage involving the cranial nerves and vessels. ALTON S. HANSEN, M.D.

**Trephine Puncture of Cystic Craniopharyngiomas with Pneumography or Opacification of the Cyst.** B. Guillaumont and G. Guiot. J. de radiol. et d'électrol. **29:** 18–24, 1948.

Craniopharyngiomas develop from cellular vestiges of the embryonal craniopharyngeal duct. They usually consist of a solid, sometimes calcified portion and of an adjacent cyst. One or the other of these elements, solid or cystic, can predominate, and the symptomatology, as well as the treatment, will vary accordingly.

There is a syndrome, common to both varieties, consisting of neuro-hypophyseal disorders, optic disorders, and radiologic signs. When evidence of increased intracranial pressure and motor disorders are added, the authors state that the tumor is probably cystic. The differential diagnosis is important because of the danger involved in removing the solid craniopharyngiomas. On the other hand, puncture of a cystic lesion is a benign procedure and always indicated. Many neurosurgeons simply evacuate the sac and remove a portion of its lining for histologic examination, without attempting to remove the tumor.

The authors first punctured a cystic craniopharyngioma through a trephine opening in the frontal bone of a child whose condition was too grave for a more radical procedure. Sixty-five cubic centimeters of greenish yellow fluid was removed and the child was able to leave the hospital in three weeks. The cyst subsequently refilled, and evacuation was again performed through the same trephine opening. Since that time, evacuation of the cystic craniopharyngioma has been performed seven times without incident.

The puncture is performed, as stated above, by means of a trephine opening in the frontal bone, at a point 2 fingers breadth in front of the coronal suture and at 2 cm. from the midline. A trocar is directed toward a point 3 cm. above the sella turcica. Puncture is followed by injection of air or 0.3 c.c. thorotrast, which allows determination of size and anatomical relationships of the lesion.

Such a puncture is especially indicated in patients whose condition does not permit craniotomy. The immediate results are dramatic. The ultimate results vary according to the rapidity with which the cyst refills. Thus, the puncture is only a palliative procedure, but it remains an interesting one for a disease the radical treatment of which is associated with a high mortality. If an operative procedure is decided upon, the opacification or pneumography of the cyst will furnish invaluable information to the surgeon. Permanent opacification of the cyst wall by the thorotrast permits observation of the evolution of the lesion.

The authors believe that evacuation of a cystic craniopharyngioma through a trephine opening, as well as its opacification or pneumography, is an original method of visualization and treatment.

RODERICK L. TONDREAU, M.D.

**Evaluation of X-Ray Diagnosis in Ophthalmology, Rhinology, and Otolaryngology.** D. H. Anthony and D. F. Fisher. J. Tennessee State M. A. **41:** 45–55, February 1948.

In the opinion of the authors, eye, ear, nose, and throat specialists are not taking full advantage of roentgenography. The various conditions in which x-ray examination is particularly useful are discussed:

*Orbit:* By means of roentgenograms the size of the orbit can be determined. Enlargement of the orbit is most frequently due to a long-standing benign intraorbital tumor. Any injury around the orbit should be examined roentgenologically, for swelling of the soft tissues frequently prevents a clinical diagnosis of fracture of the orbit; by the time the swelling disappears, it is too late to correct the fracture by surgery, for an inflammatory process of the displaced bony rim of the orbit may be present.

*Optic Foramen:* Films of the optic foramen are especially important, since enlargement of the optic foramen on one side is usually a sign of a tumor of the optic nerve. Necrosis of the optic foramen indicates a neoplasm of the bone around the foramen.

*Superior Orbital Fissure:* Deformity of the superior orbital fissure is seen in many intracranial tumors and careful x-ray studies of the superior orbital fissure should be made in every case where posterior orbital contents and the anterior brain might be involved.

*Exophthalmos:* Roentgenography is especially valuable in exophthalmos, because the history, symptoms, and clinical examination frequently fail to tell the ophthalmologist how long this space-occupying lesion has existed or to indicate the location and type of lesion,

and whether or not it is a soft-tissue or a bony tumor. The most frequent cause of exophthalmos is mucocele of the paranasal sinuses.

*Foreign Bodies of the Orbit:* The importance of the exact localization of intraocular or intraorbital foreign bodies is obvious. In addition to telling whether the foreign body is, or is not, in the globe, x-ray examination gives information as to the size, shape, and position of the long axis, and indicates less accurately what the composition of the substance may be.

*Fractures of the Nose:* Fractures of the nose are frequently accompanied by swelling of the soft tissues so that the ordinary methods of examination may be entirely inadequate. Films should be made in all cases before any manipulation is attempted.

*Nasal Accessory Sinuses:* X-ray studies of all the sinuses are essential if the rhinologist is planning to operate on them, either intranasally or externally, for he can learn something from the films that it is impossible to secure from any other type of examination.

*Fractures of the Facial Bones:* Fractures of the facial bones usually involve the sinuses. To make a diagnosis of fractures of the face, roentgenograms should be taken of all the sinuses, with any additional views thought necessary. No surgeon should attempt to give his opinion of fractures of the face without a complete set of films of this region.

*Lacrimal Sac:* Roentgenograms of the lacrimal sac are primarily taken to determine the size and shape of chronic mucocele. The shape is important, for the sac may have been injured from spontaneous rupture, after an acute exacerbation of a chronic lesion, or it may have been injured from an external opening. Injection of iodized oil is necessary for adequate study of the lacrimal sac. Of greatest importance is a diagnosis of obstruction of the common canaliculus, for in this event surgery is contraindicated.

*Acoustic Neuroma:* A tumor of the eighth nerve in the advanced stage is best demonstrated roentgenologically in films made of the apex of the petrous portion of the temporal bone. This tumor frequently causes a pressure necrosis of the internal auditory canal or the internal auditory meatus.

*Mastoiditis:* Roentgenograms in acute mastoiditis should be made as soon as there is any question of involvement. They demonstrate not only the general cloudiness, but the size and location of the cells, and show whether or not there is cavitation present. In chronic mastoiditis an x-ray picture frequently determines if the patient should have a semi-radical or radical operation.

*Petrositis:* In petrositis, roentgenograms cannot be relied on consistently. If positive, they can be of great significance, but a negative film does not necessarily rule out disease.

*Salivary Glands and Their Ducts:* Patients with symptoms referable to the salivary glands and their ducts should have complete x-ray studies to determine the presence of calculi.

*The Throat:* Roentgenography is helpful in demonstrating retropharyngeal abscesses and foreign bodies of the throat. Diverticulum and stricture of the esophagus and cardiospasm can be diagnosed only by x-ray and the use of an opaque medium.

*Pituitary Tumor:* Usually a pituitary tumor which produces enough symptoms to take the patient to an oculist can be demonstrated roentgenologically, by erosion of the posterior clinoid process and sharpening of the anterior clinoid process. Any patient with a temporal hemianopsia, unilateral or bilateral, with or without optic atrophy, should have a prompt x-ray examination of the sella turcica.

**The Radiodiagnosis of Malignant Tumors of the Rhinopharynx.** F. Baclesse and G. Dulac. J. de radiol. et d'électrol. **29:** 24–36, 1948.

In an article illustrated by excellent plates and diagrams, the authors discuss the radiographic diagnosis of malignant tumors of the nasopharynx. They consider radiography particularly valuable in neurologic patients in whom clinical examination is difficult. It not only permits demonstration of a tumor but also serves as a guide in the exact application of the fields of irradiation.

The pathologic shadows created by the lymphosarcomas, epitheliomas, and lympho-epitheliomas, which represent the most common malignant tumors of this region, cannot be differentiated. Certain lesions, however, such as epitheliomas of the eustachian tube, have characteristics which distinguish them from epitheliomas originating from the postero-superior wall (pharyngeal tonsils and fossa of Rosenmüller). These lesions usually occupy the posterior rim of the eustachian tube, and on the roentgenogram their shadows merge posteriorly with the posterior wall of the nasopharynx. They have sharp outlines, convex above and anteriorly and, in the cases which are limited to the tube, leave a clear space between their superior border and the floor of the sphenoid. These tubal epitheliomas are particularly apt to invade the bones of the base of the skull.

Lymphosarcomas do not invade bone. Since bone destruction is not always clinically manifested by pain or by nerve palsies, and since such destruction indicates a poor outcome, radiography is of particularly important prognostic value. RODERICK L. TONDREAU, M.D.

**Dislocation of Thyroid Cartilage. Report of a Case.** Ernest J. Elsbach. Occup. Med. **5:** 78–85, January 1948.

A case is reported of dislocation of the thyroid cartilage, incurred when the patient fell on the right side of the neck and lower side of the right jaw, with the chin extended. The immediate diagnosis was concussion of the brain and contusion of the chin and lateral costal and deltoid regions. There were no pathologic observations referable to the larynx—no respiratory embarrassment or hemoptysis. The patient continued to complain of pain on the left side of the front part of the neck, in the region of the hyoid bone, slight pain when swallowing, and a burning sensation in the throat on breathing. A roentgenogram of the soft tissue of the larynx fourteen months following the accident revealed "irregularity and fraying of the arytenoid cartilage and of the anterior portion of the thyroid cartilage on the basis of a fracture or dislocation." The thyroid cartilage was displaced upward and anteriorly, producing a soft-tissue prominence. The aryepiglottic ligament was not visualized as it should be. There was thickening of the soft tissue in the thyrohyoid region.

## THE CHEST

**Bronchography in Pulmonary Disease.** Douglas S. Gorrell. Canad. M. A. J. **58:** 126–129, February 1948.

Thorough bronchography is an essential feature in the diagnosis of any pulmonary lesion, but its chief

value is in suppurative conditions, as bronchiectasis and lung abscess. A brief review of the subject and a method of procedure, a slight modification of that used at the Mayo Clinic, is submitted. This consists in preliminary barbiturate sedation, direct cocainization of the hypopharynx, vocal cords and tracheobronchial tree, and insertion of an uncut French No. 16 soft rubber catheter through the nose into the trachea. Twenty cubic centimeters of iodochloral is instilled into each side separately with the patient seated and leaning over to the side to be filled. To insure segmental filling, the patient lies on the table with the side that has just been filled down, the arm on that side at right angles under him and the opposite hand above his head, grasping the foot plate of the table. The table is then tilted, head down to an angle of 45 degrees, and held there for one minute. It is then leveled, the arm under the patient is moved posteriorly, so that he is now in the oblique plane, and the table is again tilted for the same period of time. For complete mapping, three films are taken on each side, anteroposterior, lateral, and oblique. For children, a general anesthetic is used, and 10 c.c. of the opaque medium is instilled through a small catheter inserted through the anesthetic intratracheal catheter; only one side is done at a time.

WILLIAM P. MARTIN, M.D.

**The Lateral Thoracic Tomogram in the Normal Subject.** Chatton and Maleki. J. de radiol. et d'électrol. **29:** 51–54, 1948.

The radiographic anatomy of the chest, with particular reference to the lateral tomogram, is described in detail. The authors state that the cut passing 3 to 4 cm. to the right of the midline is especially valuable, since it includes the sagittal plane in which the majority of intra-hilar and intra-pulmonary bronchovascular elements are contained.

RODERICK L. TONDREAU, M.D.

**Seriographic Study of the Lungs.** Luigi Castaldi. Radiol. med. (Milan) **34:** 65–74, February 1948.

The author suggests that fluoroscopy of the lung followed by serial films should be more generally used and mentions several cases in which this method gave useful results. Of special interest were cases in which pleural adhesions were visualized and cases in which the seriographic study was employed following the injection of opaque oil in the bronchi.

CESARE GIANTURCO, M.D.

**Subcutaneous Emphysema Following Chest Trauma: Analysis of Twenty Cases.** William Sheinfeld. Surgery **23:** 278–288, February 1948.

Subcutaneous emphysema is not unusual following thoracic trauma. It may result from penetrating external wounds or tearing of the lung by fractured ribs. Most cases will resolve without intervention, but severe cases may be fatal without prompt treatment.

There are two principal mechanisms by which subcutaneous emphysema develops:

(1) With rib fractures, or in penetrating wounds of the chest, the parietal and visceral pleura and the underlying lung are lacerated. Air passes from the lung into the pleural space and thence into the chest wall. [The author states that air escapes from the lung into the pleural space on *expiration* and is forced into the chest wall through the damaged parietal pleura on *inspiration*. According to classical and well established mechanics of respiration, air escapes from the lung into the pleural space principally during *inspiration* and is forced into the chest wall during *expiration*.—J. E. W.] With continued passage of air from the lung, a pneumothorax may develop until intra-alveolar and pleural pressures are nearly enough equal that the leakage of air ceases, or until the laceration in the lung seals. Air may also pass directly from the lung into the chest wall without evident pneumothorax. [Trauma through adhesions obliterating the pleural space is suggested as one way this may occur.—J. E. W.]

(2) Overinflation of the lungs as the result of inhalation anesthesia, resuscitative measures, atelectasis with compensatory emphysema, straining, and a congenital predisposition may lead to the rupture of overdistended alveoli, or this may result from trauma to the chest with or without rib fractures. Air escapes from the alveoli into the perivascular sheaths of capillaries and larger blood vessels, and following these structures to the root of the lung and the mediastinum, and eventually entering the tissues of the neck and chest wall. It may also escape into the pleural cavity or even downward into the retroperitoneal space.

[An additional cause of emphysema originating in the bronchial tree is instrumentation during bronchoscopy—fractured larynx.—J. E. W.]

Subcutaneous emphysema interferes with vital processes mainly by compression of the respiratory tract and by hindering blood return to the heart.

Active treatment in cases of direct trauma to the lung through the chest wall may be directed toward (1) drainage of the air from the mediastinum by needle or by incision and (2) stopping the flow of air from the lung by surgical closure of the wound. Cases are cited in which mediastinal drainage of the air was life-saving through relief of pressure upon the vascular and respiratory structures. Mediastinal decompression is best done by incision in the suprasternal area. Thoracentesis and underwater drainage of air from the pleural space may interrupt extension of air into the subcutaneous tissues; tension pneumothorax may be used to compress the lung and stop further air leakage. [High intrapleural pressure may contribute to the subcutaneous emphysema.] Expectant treatment should be given and careful observation continued so that prompt intervention can be undertaken if indicated. Adequate oxygen concentration and a free airway must be assured.

Details of the author's 20 cases are presented in tabular form, and roentgenograms from two cases are reproduced. J. E. WHITELEATHER, M.D.

**Arteriovenous Fistula of the Lung.** Herbert C. Maier, Aaron Himmelstein, Richard L. Riley, and Joseph J. Bunin. J. Thoracic Surg. **17:** 13–22, February 1948.

An arteriovenous fistula not caused by trauma, infection, or degenerative changes in the walls of blood vessels is a form of cavernous hemangioma. If large communications are present, free exchange between the arterial and venous systems is possible, avoiding the capillary bed. When this occurs in the lung, cyanosis, clubbing of the fingers, and polycythemia may result. There may be a murmur over the involved area. In the absence of cyanosis, it is conceivable that the shunt is between the bronchial artery and pulmonary vessels.

Heredity seems to play a role in the occurrence of arteriovenous fistulae of the lung. The symptoms consist of dyspnea on exertion, cough, hemoptysis, epistaxis, and headache in those patients with polycythemia. In half the cases hemangiomas are also present elsewhere. The cardiac findings are normal. The red blood cell count may be as high as 11,000,000, and the hemoglobin as high as 23.7 gm.

Roentgen examination shows one or more dense areas in the lungs which may be rounded with an irregular, often worm-like border. The lesions are located medially and are continuous with the great vessels. The middle lobe is a common site. Angiocardiograms will confirm the diagnosis and is considered advisable in every case prior to surgery. Multiple lesions may be discovered in this way.

The treatment is local or segmental resection.

The authors report in detail the case of a twenty-year-old woman who had a fistula in the lower lobe on the right, with a superimposed bacterial endarteritis. She was treated with penicillin, which controlled the endarteritis, and later the lower lobe was removed with excellent results. Extensive studies on the respiratory and circulatory function were done before and after operation. The shunt through the fistula was estimated to be 58 per cent of the total blood flow at rest.

The physiological alterations produced by an arteriovenous fistula in the peripheral and pulmonary circulations are discussed. A peripheral fistula increases all elements of the blood volume proportionately, increases cardiac output, and produces dilatation of the heart. A pulmonary fistula increases only the red cell mass and has little or no effect on heart size or output. HAROLD O. PETERSON, M.D.

**Radiological Approach to Pulmonary Tuberculosis.** S. K. Montgomery. South African M. J. **22:** 131–138, Feb. 28, 1948.

Two surveys of a large number of patients (about 1,500), mainly colored, from the Cape Peninsula, South Africa, would indicate an incidence of radiologically positive pulmonary tuberculosis of approximately 5 per cent. According to this sample, if a mass roentgenologic survey were made of the entire colored population of the Cape, 10,000 cases of tuberculosis would be uncovered. The various economic and sociologic problems confronting the patients themselves, the hospitals, etc., are discussed.

After early diagnosis, the radiologist's next problem is assessment of the stage of the disease, with a view to treatment. The allergic theory of the spread of tuberculosis is put forward and explained by means of a diagram, which is correlated with a series of films showing the various radiological patterns encountered.

The importance of serial x-ray examination during treatment is stressed, especially with regard to pneumothorax and other surgical procedures. The value of fluoroscopy is emphasized and its importance for the diagnosis of cavities and adhesions is noted. In the author's opinion, tomography is of definite but limited value. He believes that stereography is so technically difficult to carry out exactly that its value is slight.

**Expiration Films in Pulmonary Tuberculosis.** D. I. Adler. South African M. J. **22:** 118–126, Feb. 28, 1948.

In estimating the extent, value and complications of pneumothoraces, fluoroscopy during full expiration and expiration roentgenograms are of inestimable assistance when interpreted in conjunction with the conventional postero-anterior film taken on inspiration. The author discusses the following conditions which may be overlooked unless such examinations are made: (1) mediastinal hernia; (2) mobile mediastinum; (3) depth of artificial pneumothorax; (4) presence of adhesions; (5) effect of adhesions; (6) confirmation of diaphragmatic paralysis; (7) non-tuberculous conditions, as (*a*) lung hernia, (*b*) partial bronchial obstruction by foreign body, (*c*) "stove-in" chest, (*d*) open traumatic pneumothorax, (*e*) hydatid cyst.

Inspiratory and expiratory roentgenograms are reproduced for comparison.

**A Case of Tuberculosis.** B. A. Dormer. South African M. J. **22:** 82–88, Feb. 14, 1948.

The case of tuberculosis recorded here is that of a young African warrior brought up under primitive conditions of life and at the age of twenty-two migrating to town, where the carefree open-air existence of his earlier years was replaced by hard labor, with crowded living quarters, lack of healthful recreational opportunities, inadequate diet, and exposure to infection. Death occurred two years after this change in living conditions. Within the compass of this typical history, the author believes, lie all the causes and all the possible methods of control of tuberculosis in South Africa.

Included in the discussion are some interesting results of mass x-ray surveys of selected groups of the South African population.

(1) The non-European is a smaller person than the European, a European child of six being equivalent in body structure to a non-European child of ten. This is especially true in towns.

(2) Calcification of the pulmonary root areas is rare in the European child; when it does occur, almost invariably, evidence of prolonged contact with a known infectious case of the disease can be established. On the other hand, calcification of the pulmonary roots is extremely common in the non-European child, especially in towns, where innumerable opportunities for infection arise.

(3) The root calcification in the non-European child is the result of selective deposition of calcium in pathological tissue, and if there is not enough calcium in the diet, then it is stolen from the patient's bony structure in order to stem the tide of infection in the lungs.

If careful comparative X-ray pictures, using phototimer technic, are taken of European and non-European children of the same age-group, it will be found that the bony skeleton of non-European children with pulmonary calcification is not uncommonly osteoporotic when contrasted with the European child as a normal.

**Besnier-Boeck's Disease with Transformation into Miliary Tuberculosis.** Jenny Müller and Alberto Pedrazzini. Schweiz. med. Wchnschr. **78:** 126–128, Feb. 14, 1948.

A 27-year-old patient had been under observation since 1937 with a so-called Boeck's disease of the hilar lymph nodes. The condition had remained stationary and the tuberculin reaction continued to be "almost" negative during a ten-year period. There then suddenly developed a miliary tuberculosis with a strongly positive tuberculin reaction and a progressive course, with death in about eight weeks. Autopsy showed miliary tuber-

culous lesions disseminated throughout the lungs, as well as changes in the hilar lymph nodes of a type usually interpreted as due to Besnier-Boeck's disease. No other source for the tuberculous dissemination could be found.

The question of the possible tuberculous etiology of sarcoidosis is discussed briefly, with citations of other published cases in which typical tuberculosis of one or another type has developed following sarcoidosis.

LEWIS G. JACOBS, M.D.

**Accidental Extrapleural Pneumothorax.** Olle Olsson. Acta radiol. **29:** 117–129, Feb. 28, 1948.

A number of cases are reported of the accidental production of extrapleural pockets of air in the course of therapeutic pneumothorax. The picture is interesting and may cause some confusion if the possibility is not borne in mind.

The underlying condition is a detachment of the parietal pleura during the injection of the air for collapse therapy. In the roentgenogram, the detached pleura is visible as a membrane bulging out from the chest wall. The extrapleural pneumothorax cavity outlined by the membrane may be an entirely free space varying in width from case to case, depending upon the amount of gas deposited extrapleurally. It may also be more or less partitioned either by bands or by broad adhesions of the pleura over small areas, producing a wavy medial outline. The extrapleural collection of gas is column-shaped (when the separation of the pleura is extensive) or cyst-shaped. Its absorption requires a long period—months or even years—with a consequent long-standing reduction of the pneumothorax cavity of greater or less extent.

If the pocket is too large and touches the collapsed lung, the two pleural surfaces may adhere and the collapse will be lost as the extrapleural air is absorbed. In one of the author's cases this sequence of events occurred.

ZAC F. ENDRESS, M.D.

**Foam Formation in Cases of Hydropneumothorax.** Umberto Cocchi. Radiol. clin. **17:** 35–42, January 1948.

Torelli published in 1927 a report of 18 cases of pneumothorax in which he observed smooth and irregular fluid levels on the roentgenogram. He expressed the opinion that a rough surface indicates an actual or potential empyema.

Among 87 cases observed by the present author, 69 showed a smooth fluid level and 18 (20 per cent) a rough surface. Most of the cases were tuberculous; others represented a variety of infectious diseases, injuries, etc. No typical relationship was found to exist between the appearance of the fluid level and the characteristics of the fluid. Among 42 cases with serous exudate there were 32 with a smooth and 10 with a rough fluid level; 17 hemothorax cases showed 15 smooth and 2 rough fluid levels; among 22 cases of empyema with thin pus a smooth surface was observed 16 times and a rough surface 6 times. In 6 cases of empyema with thick pus the fluid level was smooth in all.

Experiments with water, serous exudate, hemorrhagic exudate, and thin and thick empyema fluid revealed that foam formation is caused by shaking. Two cases are mentioned in which, after shaking the patient, the fluid level showed a roughening of the surface. The conclusion is reached that a rough fluid level does not indicate pus or empyema, but is caused by motion, either externally or internally (heart action or coughing). If the rough surface shows rather large dents and irregularities, it probably indicates an empyema with thin pus.

EUGENE F. LUTTERBECK, M.D.

**Metal Fume Fever.** J. W. E. Raine. New Zealand M. J. **47:** 24–28, February 1948.

The term "metal fume fever" embraces such entities as brass founders' ague, smelter shakes, zinc chills, brass chills, and founders' fever. It may be caused by several substances, one of which is zinc oxide. A case believed to be due to the latter substance is presented and the roentgenographic signs are described, the author believes for the first time. [See, however, Jones and Lockhart: Texas State J. Med. **39:** 532, 1944. Abst. in Radiology **43:** 405, 1944.]

The patient was an electric welder who inhaled a large quantity of fumes while welding galvanized iron beds eight hours a day for two days. The striking clinical feature was marked dyspnea on the slightest exertion. This was associated with severe cough, some cyanosis, chest pain, hemoptysis, and low-grade fever. The physical examination of the chest was negative. The blood count showed a slight anemia and moderate leukocytosis. The sputum was not remarkable. The chest film revealed "widespread abnormal shadows in the left midzone and a similar condition to a lesser degree in the right upper lobe." The patient responded to sulfadiazine and general supportive care and the roentgen picture was normal two weeks following the onset of symptoms.

EDWARD E. LEVINE, M.D.

**Primary Carcinoma of the Lung. A Report of Forty-Eight Cases.** D. W. Quick, Jr., and Paul Brindley. Texas State J. Med. **43:** 627–630, February 1948.

In a series of 48 cases of carcinoma of the lung a diagnosis was made in 33 by correlation of the findings on roentgenography, needle biopsy, and bronchoscopy. Concerning roentgen examination, the authors say: "No diagnosis of carcinoma should be made from flat plates and stereoscopic films alone; multiple angulated plates should be taken. The commonly used flat plate may record shadows which are misinterpreted, while stereoscopic films alone may allow the lesions to remain hidden behind overlying structures." The roentgen findings were significant in 21, or 43.6 per cent of the present series. They included: cavitation, rib destruction, central infiltration, atelectasis, effusion, hilar node involvement, parenchymal infiltration. The most important adjunct in confirming the roentgen observations was bronchoscopic biopsy.

**Roentgen Examination of the Mediastinal Lung Hernia with Reference to Tomography.** Hans Salinger. Acta radiol. **29:** 130–138, Feb. 28, 1948.

The herniation of a lung through the mediastinum into the opposite chest is not always demonstrable with plain films. By the use of tomography the edge of the herniated lung was easily seen in the author's cases, as well as the displacement of the apical vessels.

These hernias usually occur following pneumonectomy or lobectomy or extreme fibrosis of the lung and/or the pleura where there is a marked difference in pressure in the two sides of the chest. Six cases are briefly reported.

ZAC F. ENDRESS, M.D.

**Differential Diagnosis of Congenital Heart Disease.** Martin M. Maliner. New York State J. Med **48:** 407–411, Feb. 15, 1948.

For the differential diagnosis of congenital heart lesions, it is of first importance to place the case in one of two categories: acyanotic and cyanotic. The next important consideration is the heart murmur, with its point of maximum intensity, relation to the cardiac cycle, area of transmission, and quality.

The most important defects causing heart murmurs in the acyanotic group are: (*a*) patent interventricular septum (small); (*b*) patent ductus arteriosus; (*c*) aortic coarctation; (*d*) subaortic stenosis. Patent foramen ovale also belongs in this group, but since it rarely presents any signs or symptoms, it is not considered here. The cyanotic group includes: (*a*) pulmonary stenosis; (*b*) large septal lesion (ventricular or auricular); (*c*) Eisenmenger complex; (*d*) transposition of the great vessels.

The important features of each of the eight conditions listed above are concisely set forth. The roentgen picture is characteristic in only two of the acyanotic group. In *patent ductus arteriosus* the heart is either normal in size or slightly enlarged, with a distinct prominence of the pulmonary aorta. This feature is, however, frequently absent. The fluoroscope may show the so-called hilar dance. In *coarctation of the aorta* the distinctive features are notching of the ribs and absence of the aortic knob.

In *pulmonary stenosis*, usually a component of the tetralogy of Fallot, the x-ray reveals the *coeur de sabot* or "boot-shaped" heart, due to the right-sided enlargement, elevating the apex of the left ventricle and producing a double apex. The heart itself is of normal size or only slightly enlarged, with characteristic absence of the pulmonary arch. Because of the deficient circulation in the lungs, there is an unusual absence of pulsations in the hilar vessels.

With a *large patent interventricular septum* the heart is large and bottle-shaped, with no distinct pulmonary bulge. With a *patent interauricular septum*, there is a large pulmonary artery with enlarged lung hilar shadows.

In the *Eisenmenger complex*, the heart shows slight enlargement, with a greatly enlarged pulmonary arch due to hypertrophy of the conus and dilatation of the pulmonary artery. The hilar shadows are increased and a hilar dance is demonstrable. With transposition of the great vessels the roentgen picture is not significant.

**Fluorocardiography (Electrokymography). I. Technical Aspects.** Aldo A. Luisada, Felix G. Fleischner, and Maurice B. Rappaport. Am. Heart J. **35:** 336–347, February 1948.

The recording of the motions of the heart chambers and large blood vessels by means of the fluoroscope, an electron multiplier, photoelectric cell as a pick-up device, and a phonocardiograph-electrocardiograph, the authors designate as fluorocardiography, in preference to the term electrokymography. The apparatus is essentially the same as that described by Henny, Boone, and Chamberlain (see Absts. in Radiology **47:** 88, 1946; **50:** 848, 1948), plus modifications to increase sensitivity. The authors describe the apparatus and their modifications, show how they obtain increased sensitivity, and indicate what they believe are the points of superiority in their procedure. They also describe how they eliminate interference from electrostatic radiation from high tension, flicker due to cyclic discontinuity of the x-ray beam, and fluctuation of the power line.

A tracing can be obtained of the motion of any portion of the cardiac silhouette or large blood vessels by placing the slit in the pick-up device across the margin of the visible shadow. A *densogram* is obtained by placing the slit entirely within the shadow of a structure.

Studies were made of healthy subjects in the recumbent and sitting positions, utilizing various portions of the cardiovascular and pulmonary structures in postero-anterior and oblique projections.

The polarity of the apparatus is arranged so that increased brilliance causes a downward movement on the tracing. Therefore, a fall in the curve indicates inward movement across the slit, or a decrease in thickness of the structure if the slit is over a homogeneous area. A rise in the curve indicates expansion, or increased thickness of structure (densogram). The phonocardiogram is used for timing. Any kymographic wave occurring before the first large vibration of the first sound is presystolic; any wave occurring after the last vibration of the second sound is diastolic; and any wave taking place between the beginning of the first sound and the end of the second sound is systolic.

HENRY K. TAYLOR, M.D.

**Fluorocardiography (Electrokymography). II. Observations on Normal Subjects.** Aldo A. Luisada, Felix G. Fleischner, and Maurice B. Rappaport. Am. Heart J. **35:** 348–366, February 1948.

Fluorocardiography, as described in the preceding abstract, was carried out over various cardiovascular structures in 20 normal subjects and found to present characteristic patterns. The authors illustrate, describe, and evaluate the tracings obtained at the following locations: left ventricular apex; convexity of left ventricle above the apex; left ventricle in oblique projections; right ventricle; left auricle; right auricle; ascending aorta; aortic arch; descending aorta; pulmonary artery; hilar region; lungs; superior vena cava, and inferior vena cava. These tracings are compared with simultaneous recordings of phonocardiograms.

The identification of the various waves and their relation to the phases of the cardiovascular dynamics are discussed. They may be attributed to two different phenomena: (1) motions of the x-ray silhouette caused by changes in volume in systole and diastole, and (2) motions due to rotation, traction, or total shift due to contraction or dilatation of either the same or some other cardiovascular structure.

HENRY K. TAYLOR, M.D.

**Dynamics of the Left Auricle in Mitral Valve Lesions. Fluorocardiographic Study.** Aldo A. Luisada and Felix G. Fleischner. Am. J. Med. **4:** 791–797, June 1948.

As described in a previous paper (Am. Heart J. **35:** 348, 1948. See preceding abstract), fluorocardiographic tracings in normal subjects present a characteristic pattern. Tracings of the left auricle in 23 patients with lesions of the mitral valve also showed a typical pattern in 9 of 10 patients with fibrillation and in 10 of 13 patients with sinus rhythm. This consists of a positive plateau, which is evidence of expansion of the left auricle during ventricular systole because of regurgitation. Another variation, consisting of abnormalities in shape

and depth of the presystolic auricular wave, is found in certain patients with sinus rhythm and is explained on the basis either of severe narrowing of the mitral valve or a structural lesion of the left auricular wall.

The practical diagnostic value of these graphic signs is discussed.

Possible existence of a pure mitral stenosis, not accompanied by mitral insufficiency, was not demonstrated in the present study.

**Roentgenological Heart Volume Determination with Special Regard to Pulse Rate and the Position of the Body.** Harry Larsson and Sven Roland Kjellberg. Acta radiol. **29:** 159–177, Feb. 28, 1948.

Discussing the various methods which have been proposed for the determination of heart volume, the authors show that the most accurate and at the same time the most practical method is the use of the formula $d_1 \times d_2 \times d_3 \times k =$ volume, where $d_1$ is the long diameter and $d_2$ the broad diameter, on the postero-anterior film, and $d_3$ the depth or the anteroposterior diameter through the center of the heart in the lateral view. (The heart measurements must be corrected for magnification before being used.) The factor $k$ has been assigned a constant value by some authorities. Actually, however, it varies with the shape and tilt of the heart. The "index" of the heart must first be determined by dividing the frontal area into the square of the depth. Then by referring to a curve reproduced in the article one can obtain the figure for $k$.

Extensive studies were made of the effects of changing position and pulse rate on the heart volume. It was found that the volume decreased in the upright position because of pooling of blood in the viscera and lower extremities. When this pooling was prevented as much as possible by tourniquets on the thighs, very little change in volume could be determined.

Increasing the pulse rate showed no change up to 80 per minute, but above this figure there was a proportional decrease in volume. This is accounted for by the shortening of diastole and the consequent lesser degree of filling at higher pulse rates. The amount of decrease was found to be less than stated by other workers—amounting to about 15 per cent when the pulse rose as high as 120 per minute.

The conclusion is reached that, to determine heart volume with any degree of accuracy, the examination should be done in the horizontal position. Electrocardiographic control must be in the circuit to permit exposures to be made at the time of maximal filling, *i.e.*, at the end of diastole. ZAC F. ENDRESS, M.D.

**Kymographic Studies of the Function of the Auricle.** Bryan Fabricius. Acta radiol. **29:** 152–158, Feb. 28, 1948.

On reviewing the literature on the physiology of the auricular appendage, one finds rather widely contrasting opinions of its importance. Some authors attribute to it a piston-like contraction responsible for most of the emptying of the atria, while others believe it to be practically functionless, serving only as a reservoir when venous return is suddenly increased.

By taking simultaneous kymograms and electrocardiograms, the author was able to show that the auricle has no independent regular muscular action, for there was no consistent motion in either direction at any point in the cardiac cycle. It would seem that the auricle serves only as a complementary space during ventricular systole, to keep the surface of the heart constant. ZAC F. ENDRESS, M.D.

**Thoracal Aortography by Catheterization from the Radial Artery: Preliminary Report of a New Technique.** Stig Radner. Acta radiol. **29:** 178–180, Feb. 28, 1948.

A new technic for contrast visualization of the thoracic aorta and branches is presented, having the definite advantage of enhanced contrast because of less dilution of the opaque medium by the venous blood.

Instead of injecting a vein and having the medium traverse the pulmonary circuit to reach the aorta, the author exposes, ligates, and catheterizes the radial artery. The catheter is passed in a retrograde manner with fluoroscopic control until the ascending aorta is reached. Then 30 c.c. of 50 or 70 per cent diodrast are injected as rapidly as possible and films are exposed—one after injection of 20 c.c., one after 30 c.c., and a third one a second later.

The technic was devised to give more exact information to the surgeon planning to operate for coarctation of the aorta and patent ductus arteriosus. [See following abstract.] ZAC F. ENDRESS, M.D.

**Thoracic Aortography: Preliminary Report.** B. Brodén, H. E. Hanson, and J. Karnell. Acta radiol. **29:** 181–188, Feb. 28, 1948.

The authors have refined somewhat the technic presented in the article by Radner (see preceding abstract) and present 3 cases illustrating the procedure. They used 50 c.c. of diodrast instead of 30; took 2 films simultaneously in planes at right angles to each other; and finally, by clamping and incising the artery, they were able to suture the opening and thus save the vessel in 2 of their 3 cases.

In one of the cases the findings were normal, though venous catheterization and gas analysis had suggested a patent ductus. In the other two cases coarctation was revealed, with a possible patent ductus in one.

The illustrations reproduced show excellent visualization of the thoracic aorta and its branches. The stenosis at the isthmus is clearly seen. The only subjective symptom observed so far has been a feeling of heat in the head, lasting a short time. It would seem that this method is to be preferred to venous injection when the aorta is under study. ZAC F. ENDRESS, M.D.

**Hiatus Hernia Confused with Coronary Thrombosis.** George C. Linn. New York State J. Med. **48:** 303–306, Feb. 1, 1948.

Three cases are reported in which complaints referable to the chest led to a diagnosis of myocardial disease due to coronary thrombosis. In each case roentgen examination eventually showed a hiatus hernia. The author believes that the pain in such cases is probably initiated over the visceral afferent fibers supplying the esophagus and cardiac portion of the stomach, or over the sensory afferent fibers from the diaphragm contained in the phrenic or middle or lower thoracic nerves, and that it is therefore referred to the same segments as cardiac pain. Thus, overdistention or irritation of the herniated portion of the stomach may be responsible for the production of the anginal or coronary type of pain. The differentiation is important because of the serious prognosis in coronary thrombosis. It can be made with

comparative ease once the presence of hernia is suspected. Roentgenograms of the three cases are reproduced.

**Traumatic Diaphragmatic Hernia.** Felix Hughes, Earle B. Kay, R. H. Meade, Jr, T. R. Hudson, and Julian Johnson. J. Thoracic Surg. **17:** 99–110, February 1948.

This paper consists of an analysis of 28 cases of traumatic diaphragmatic hernia, all successfully treated surgically. Sixteen of these were due to war wounds of the diaphragm, 9 followed automobile accidents, 2 resulted from falls, and 1 followed a stab wound. The right diaphragm was involved 5 times and the left diaphragm 23 times. When the right side was injured, the liver or kidney herniated. On the left side there was usually a gas-filled viscus in the chest. In one case, only omentum herniated into the chest. Several films are shown illustrating the different types of cases. All the patients were operated upon through a thoracic approach, and phrenic nerve paralysis was considered advisable.

Slight injuries to the diaphragm may give rise to herniations at a later date. This should be kept in mind in patients who have had chest injuries and later present symptoms referable to the upper abdomen and chest.

HAROLD O. PETERSON, M.D.

## THE DIGESTIVE SYSTEM

**Diagnosis and Treatment of Atresia of the Esophagus and Tracheo-Esophageal Fistula.** Orvar Swenson. Pediatrics **1:** 195–204, February 1948.

In the past eight years at the Children's Hospital (Boston), 113 cases of atresia of the esophagus and tracheo-esophageal fistula have been operated upon and 57 of the patients have survived. In the series of 32 primary anastomoses, there were only 5 postoperative deaths. This low mortality is attributed to the following factors: (1) earlier diagnosis, in consequence of which the babies are sent to the hospital before an overwhelming pneumonia develops; (2) improved preoperative as well as postoperative care; (3) changes in operative technic.

Excessive saliva in a newborn baby suggests the possibility of atresia of the esophagus. This anomaly should also be suspected if the first and subsequent feedings are immediately regurgitated and the vomiting is followed by cyanosis. The presence of an atresia can easily be proved by inserting a No. 8 soft rubber catheter into the esophagus and demonstrating an obstruction in the upper third. In the rare case of tracheo-esophageal fistula which is not associated with atresia of the esophagus, a catheter will pass into the stomach.

As a first step in determining the type of malformation, 0.5 to 1.0 c.c. of lipiodol should be injected slowly through the catheter into the esophagus. This is done with the baby under the fluoroscope, in order to guard against an overflow of the medium into the trachea. Barium should not be used, for its aspiration may result in a severe pneumonia. If the roentgenogram demonstrates no gas pattern in the intestine and a blind upper pouch, the atresia is not associated with a tracheo-esophageal fistula. A blind upper pouch with a gas pattern in the intestine indicates an associated tracheo-esophageal fistula to the lower segment. Should lipiodol enter the trachea and no gas be present in the intestinal tract, the fistula involves the upper esophageal segment. If lipiodol enters the trachea and there is a normal intestinal pattern, there is a double fistula—one to the upper and one to the lower esophageal segment. A roentgenogram may outline a normal esophagus and lipiodol in the trachea and thus demonstrate a tracheo-esophageal fistula without atresia of the esophagus.

Associated anomalies should be sought for, as they are fairly common. Among the 113 cases, 80 malformations of various kinds were found, many of these being multiple in a single patient.

The preoperative and postoperative care of infants with esophageal atresia is of the utmost importance and is discussed in detail.

**Mass Survey of the Gastro-Intestinal Tract.** Paul C. Swenson. South. M. J. **41:** 108–112, February 1948.

Gastric carcinoma is said to be responsible for about 40,000 deaths per year. Despite increased efforts of internists and radiologists toward early diagnosis, improved surgical approach, better pre- and postoperative care, present results remain discouraging. Improved resectability rates and decreased operative mortality have been reported in major clinics, but survival rates have not appreciably improved. The need for still earlier diagnosis is obvious. Swenson suggests the possible application of the "mass survey" method to this problem, citing a fluoroscopic study of 2,500 asymptomatic patients, carried out in conjunction with St. John and Harvey (Ann. Surg. **119:** 225, 1944. Abst. in Radiology **46:** 200, 1946). Three early carcinomas were discovered in addition to several other lesions.

The practicability of performing such "mass surveys" is discussed. The magnitude and complexity of the procedure is admitted. Cold figures may appear discouraging, but trial surveys seem warranted from a moral or humanitarian standpoint, at least until the actual cause or cure of cancer is uncovered. It is suggested that examinations be limited to asymptomatic males over fifty years of age. A fluoroscopic time of 30 seconds to one minute seems adequate to determine a normal stomach. The advisability of examining select groups (such as patients with achlorhydria or hypochlorhydria) is felt to be a step in the right direction.

At the present time a mass survey is being conducted in Philadelphia, on material obtained from the Detection Clinics of the Donner Foundation. Instead of fluoroscopy, a 70-mm. photofluororoentgenographic unit is being utilized. One anterior-posterior and two oblique views are made in the erect position. The great advantage of fluoroscopy is lost but the procedure enables more than one individual to view the films. The survey is incomplete at present but no cases of carcinoma have been discovered in over 500 examinations. Known early cancers *were* spotted, however, by one not aware that these known cases were purposely included. Swenson holds out high hopes that the yield of positives will be at least as high as by the fluoroscopic method.

WILLIAM G. JOHNSON, M.D.

**Problem of Early Diagnosis of Cancer of the Stomach.** Albert W. Hartman. Texas State J. Med. **43:** 637–640, February 1948.

In his discussion of the early diagnosis of gastric cancer, the author emphasizes the importance of early roentgen studies and cites the practice of trying a period of medical care for "changes in digestive habits" before roentgen examination and gastric analysis as one of the

great factors responsible for the failure to find the lesion early. Roentgen examination of the stomach and duodenum should become a routine part of the widely advocated physical check-up after the age of 45; and such examination certainly should be done on any patient over 45 who complains of a "change in digestive habits" before any type of conservative therapy is instituted. This poses a grave economic problem and will result in many so-called "unnecessary examinations," but the results will be gratifying.

**Congenital Atresia of the Small Intestine in the Newborn. Report of Two Cases, With a Review of Successfully Treated Intrinsic Obstructions of the Small Bowel.** James F. O'Neill, Katherine Anderson, Howard H. Bradshaw, Robert B. Lawson, and Felda Hightower. Am. J. Dis. Child. **75:** 214–237, February 1948.

In this contribution to "Progress in Pediatrics," the authors have compiled from the literature all the reported cases of complete atresia of the small intestine in which surgical repair was followed by recovery. In a certain number, the diagnosis, though probable, was not certain, and these are tabulated separately. Cases in which the diagnosis was definite numbered 34, and to this group 2 new examples are added.

Of the roentgenographic aspects, the authors write: "A plain roentgenogram of the abdomen will often suffice to establish the diagnosis of obstruction by outlining the distended stomach or intestinal loops proximal to the atresia. The oral administration of barium sulfate to patients with suspected atresia is both condemned and condoned by various authors. If it is felt necessary to employ barium in making a study of these infants, a small amount should be used, and then only when there is good reason to feel that the lesion is high, so that the barium can be aspirated from the stomach and duodenum before celiotomy. The presence of intraperitoneal calcified shadows on the plain roentgenogram may furnish strong evidence that an obstructive lesion of the intestine exists."

Calcified areas were demonstrable in both the authors' cases but had disappeared four days after operation.

A comprehensive bibliography is included.

**Evaluation of the Roentgenologic Diagnosis of Lesions of the Rectum and Sigmoid.** W. W. Green. Am. J. Surg. **75:** 348–354, February 1948.

The author presents several cases of congenital malformations and fistulas in the anorectal region in which the x-ray findings were of considerable aid to the proctologist in the diagnosis. Several other cases are then presented with lesions in the rectum and rectosigmoid region in which the x-ray findings were proved inadequate or incorrect on sigmoidoscopic study. A closer co-operation between the roentgenologist and proctologist in the examination of the colon is therefore urged, since together they can often arrive at a more accurate diagnosis than either can reach alone.

J. H. FREED, M.D.

**Mesenteric Cysts: Review of the Literature and Report of a Calcified Cyst of the Mesentery.** Arkell M. Vaughn, William M. Lees, and James W. Henry Surgery **23:** 306–317, February 1948.

The rarity of cysts of the mesentery is noted. The case reported is believed to be the third among some 750,000 admissions to Mercy Hospital, Chicago, in ninety-eight years. The cyst, asymptomatic and discovered during a physical examination, was in the base of the jejunal mesentery close to the ligament of Treitz. Surgical removal was effected. Pathologically the cyst was considered as lymphogenous because of its inspissated chyliform contents and the prominent lymph channels in its wall, some containing foamy, fat-laden macrophages.

The etiology and pathology of mesenteric cysts remain somewhat obscure. They have been variously classified according to origin and histology. Except for pain, the symptoms are due to complications, principally obstruction. A single scout film of the abdomen is seldom of great assistance in diagnosis, since many of these cysts are not radiopaque and cast no shadow. Occasionally, as in the case reported, the cyst wall contains sufficient calcium to be demonstrable.

Treatment consists of (1) total removal or enucleation, the procedure of choice; (2) enucleation followed by resection of the portion of intestine left with impaired blood supply; (3) marsupialization, which is a last resort; (4) aspiration, to be condemned except for diagnostic purposes or to facilitate removal.

An excellent and complete bibliography is appended.

J. E. WHITELEATHER, M.D.

## THE MUSCULOSKELETAL SYSTEM

**A Substitute for Skeletal Age (Todd) for Clinical Use: The Red Graph Method.** S. Idell Pyle, Arvin W. Mann, Samuel Dreizen, Harriet J. Kelly, Icie G. Macey, and Tom D. Spies. J. Pediat. **32:** 125–136, February 1948. **The Red Graph and the Wetzel Grid as Methods of Determining the Symmetry of Status and Progress During Growth.** Arvin W. Mann, Samuel Dreizen, S. Idell Pyle, and Tom D. Spies. Ibid, pp. 137–150.

In 1937 Todd presented his standard of reference and described the roentgenologic technic for assessing the stages of skeletal development (Todd,. T. Wingate: Atlas of Skeletal Maturation, St. Louis, C. V. Mosby Co., 1937). The original Todd graph averaged the most advanced and the least advanced "cartilage-replacement-by-bone" centers and plotted this average as a point against the child's chronological and bone maturation age in order to estimate his skeletal maturity. In order to represent a true index, however, it is necessary to portray the most advanced maturation age as compared with lagging ossifications, and this is accomplished by means of a "line" plotted against the same factors as the point described above. This has been titled the "red graph method." The resulting graph is in the form of a zone instead of a curve. Comparison is made with Todd's standard curve of reference.

When this method is used in conjunction with the Wetzel grid, which reduces height and weight to graphic form, an expression of growth symmetry is visualized when referred to the child's age. It was found that the developmental age (Wetzel) and the skeletal age (Todd) were seldom identical and not always interchangeable as measures of the maturation stage which a child has reached; of course, his own mode of progress must be considered here. When the Todd and Wetzel methods were used together, more of the developmental symmetry of the body as compared with the skeleton (the soft tissue-bone interrelations) was revealed.

These methods have been utilized in clinics for the study of nutritional problems and have been of considerable aid. Case histories with graphs illustrate the points made by the authors.

HARRY J. PERLBERG, JR., M.D.

**Osteogenesis Imperfecta and Osteogenesis Imperfecta Cystica.** H. A. Thomas Fairbank. J. Bone & Joint Surg. **30B:** 164–186, February 1948.

Osteogenesis imperfecta is a disease of unknown etiology characterized by fragility of bones. Cases may be grouped as prenatal and postnatal, but there is no clear-cut distinction between the two. Prenatal cases, however, are usually more severe. Hereditary and familial influences are present in a minority of both groups. Both sexes are affected. Blue sclerae may be seen in either group, but are more common in postnatal cases. Otosclerosis may occur late in the disease and deafness is not uncommon. Osteomalacia may be present in addition to fragility. The number of fractures is extremely variable; a new-born child may have as many as one hundred. Dwarfing is characteristic of the more severe cases, due in large part to deformities of the limbs and spinal curvature. The skull is broad, with prominent parietal and occipital bones. The intelligence is average. The blood chemistry is usually normal.

The essential pathological feature is imperfect formation and imperfect calcification of bone trabeculae.

Three types of radiographic appearance occur: (1) The thick bone type is to be seen in severe prenatal cases, with stunted limbs and numerous fractures at birth. The long bones are short and thick. (2) The slender fragile bone type is seen in prenatal cases with a survival of more than a few months and in all postnatal cases. Osteoporosis, slender long bones, thin cortex, and sometimes honeycombing of the bones are features of this group. Transverse lines are present at the metaphyseal ends. (3) Osteogenesis imperfecta cystica, characterized by pronounced honeycombing of the bones, is very rare. It dates from birth and is definitely progressive. The cystic changes are more pronounced in the lower extremities. During the first few years the upper limbs may show nothing more than osteoporosis.

The author presents 12 cases with numerous illustrations representing the various groups described above.

JOHN R. HODGSON, M.D.

**Infantile Cortical Hyperostosis.** H. H. Shuman. J. Pediat. **32:** 195–202, February 1948.

The author presents a detailed case report of the newly recognized syndrome, infantile cortical hyperostosis.

The patient, a four-month-old boy, was admitted to the hospital because of a ten-day history of fever (101–102° F.), irritability, rhinitis, and dry unproductive cough. There was a brawny bilateral symmetrical swelling of the lower jaw, first noticed by the mother the day before admission. The child did not appear acutely ill but was markedly irritable, especially when the face and jaw were touched. Laboratory examinations showed a rapidly developing anemia and constant leukocytosis. Repeated throat cultures revealed *Staphylococcus aureus*, but this organism could in no way be considered as the etiologic agent in this case. After the thirty-seventh hospital day, tender masses appeared over the left clavicle. The swelling of the face progressed to involve the entire mandible, extending up to the lower eyelids, and remained almost five months. The temperature fluctuated between 99 and 102° F. during the hospital stay. Penicillin, sulfadiazine, antihistamines, and an elimination diet were tried, but none of these influenced the course of the disease.

Roentgenographic examination showed subperiosteal new bone formation about the mandible. The new bone was amorphous, with irregular margins, and in places showed slight lamellation. Similar changes were noted about the clavicles and ribs. The changes were most marked in the anterior half of the ribs.

The end-result, as in all cases reported, was favorable. The condition ran a course of six months, and the activity in the affected bones subsided, leaving no apparent residual effects. The author calls attention to the unaltered growth and development of the patient throughout the prolonged course of the disease.

JOSEPH C. FURNARI, M.D.

**Eosinophilic Granuloma of Bones with Involvement of the Lungs and Diaphragm.** Alfred J. Ackerman. Am. J. Roentgenol. **58:** 733–740, December 1947.

A boy of 19 years had numerous scattered skeletal defects, an associated diabetes insipidus, and involvement of the lungs and diaphragm. Biopsy of one of the bone lesions led to a diagnosis of eosinophilic granuloma. The author discusses rather fully the possible relationship of eosinophilic granuloma to Letterer-Siwe's disease and Hand-Schüller-Christian disease. He believes that the classification of cases of eosinophilic granuloma as a separate entity from Hand-Schüller-Christian disease is perhaps improper and suggests that the pathologic features of the eosinophilic granuloma may be only an early manifestation of the basic disorder. It appears possible that there are significant variations in the evolution of the fundamental pathologic process, and that the clinical manifestations of the disease in its chronic forms depend largely on the localization of the lesion. It is doubtful that the acuteness of the disease in a given case can be determined from the histopathological appearance of any single lesion.

This is believed to be the first report of involvement of the diaphragm in eosinophilic granuloma.

G. K. VOLLMAR, M.D.

**Radiologic Appearance of Osteo-articular Lesions of Malta Fever.** P. Bétoulières and A. Maleki. J. de radiol et d'électrol. **29:** 1–9, 1948.

The authors reviewed 200 consecutive cases of Malta fever treated in the Hospitals of Montpellier, France. Bone involvement varied from simple arthralgia to suppurative arthritis. About 80 per cent of the patients had more or less transitory pain, while 15 per cent had radiographic evidence of the disease. Distribution of the radiologic lesions was as follows: sacroiliac joints, 12 cases; lumbar spine, 10 cases; thoracic spine, cervical spine, and hip, 2 cases each; wrist, 1 case.

The osteo-articular manifestations may be observed at all stages of the disease, but in the majority of cases they occur several months after its onset, coinciding with a febrile exacerbation. An occasional case of pure osteitis is seen, but usually the joints are involved.

From the roentgenographic point of view, brucellosis should be differentiated primarily from tuberculosis and secondarily from other arthritides, such as typhoid and gonorrhea. The resemblance to tuberculosis is so striking that the disease has been given such names as "melitococcic Pott's disease" and "Mediterranean pseudocoxalgia." In brucellosis, however, the lesions develop with much greater rapidity than they do in tuberculosis. In general, the lesions are less destructive and less extensive, sequestra are minimal, decalcification is less severe, and there is little tendency to ankylosis. As compared with tuberculosis, signs of repair occur precociously. There is rapid condensation, limiting the foci of necrosis. The accelerated appearance of osteophytes and calcification of peri-articular ligaments is often seen in brucellosis.

The diagnosis is usually definitely established by means of laboratory procedures.

RODERICK L. TONDREAU, M.D.

**Plasma Cell Tumours.** George Lumb and T. M. Prossor. J. Bone & Joint Surg. **30B:** 124–152, February 1948.

This review of plasma-cell tumors is based on 15 cases, the histories of which are included. These tumors the authors divide into three large groups: (1) bone marrow tumors, (2) extramedullary or soft-tissue tumors, and (3) generalized spread either from bone or soft tissue. They use the term multiple myelomatosis to refer to cases in which a number of bones are involved. Single tumors are described as solitary plasmocytoma either of bone marrow or soft tissue, according to their origin.

The clinical features of myeloma are discussed with respect to incidence, location of involvement, and signs and symptoms, with some attention to these aspects of the extra-medullary type of plasma-cell tumors.

Roentgenologically, multiple myelomatosis produces multiple clear-cut, punched-out oval or round patches of complete translucency from 1 to 3 cm. in diameter, with complete lack of new bone formation. Solitary plasmocytoma may present itself in two forms. One form is trabeculated, cystic, and sharply limited, located usually in the pelvis or long bones, and frequently expanding the cortex. The other is purely destructive and similar to the osteolytic type of metastatic carcinoma or osteogenic sarcoma.

The commonest site of soft-tissue plasmocytomas is the upper air passages, and the tumors must be differentiated from carcinoma and sarcoma.

The gross pathologic appearance of plasma-cell tumors is that of a soft red or purple vascular lesion. Local invasion of bone may cause pathologic fracture. The cells, as observed in the authors' series, measured 10 to 14 microns in diameter. They were ovoid, polygonal or piriform in shape with a nucleus containing a nucleolus and often eccentrically placed. The nucleus was composed of dense chromatin arranged around the periphery.

The authors believe that Bence-Jones proteinuria is probably associated with total bone marrow involvement by tumor. It was present in one of their cases of solitary plasmocytoma, but is not found with the soft-tissue tumors. The association of amyloid disease with multiple myelomatosis is mentioned, but no instance of amyloidosis was observed in the series reported. Renal changes and peripheral blood changes are discussed.

The treatment for multiple myelomatosis is solely palliative. Individually the tumors are very radiosensitive and the authors recommend 2,500 to 3,000 r delivered to each tumor over a period of three to four weeks.

For solitary tumors they prefer irradiation at high voltage through multiple ports, with delivery of 3,500 to 4,000 r to the tumor in four to six weeks. For soft-tissue tumors of the nasopharynx the treatment of choice is excision with irradiation.

The conclusion is reached that this disease should be regarded as of multifocal origin and that it may exist in a variety of forms which should not be regarded as distinct diseases but as gradations of an essentially similar process.

JOHN R. HODGSON, M.D.

**Criteria of Healing in Fractures Following Internal Fixation.** Edgar M. Bick. New York State J. Med. **48:** 277–279, Feb. 1, 1948.

The criteria of healing in fractures following internal fixation are special and differ from the criteria of healing in fractures treated by other methods. At present, they are chiefly negative in character, that is, absence of x-ray evidences of complications which indicate weakening of the fixation. These evidences are local atrophy about the metal or the appearance of significant amounts of external ossific callus. A narrow strip of external callus along the plate or on the opposite surface, or a small knob at the fracture line, is all that is permissible in normal healing. The only positive criterion is obtained by observation during a short period of guarded function. In uncomplicated, well healed fractures there will be no change in alignment.

**Recurrent Dislocation of the Shoulder.** J. Crawford Adams. J. Bone & Joint Surg. **30B:** 26–38, February 1948.

This paper is based on a review of 180 cases of recurrent dislocation of the shoulder joint. The cases are discussed from the standpoint of pathology, mechanism of production of the dislocation, and operative treatment.

Surgical examination of cases of recurrent dislocation revealed that over three-fourths showed detachment of the glenoid labrum, anterior capsular stripping, and a bone defect of the head of the humerus. The tendency to redislocation always follows injury, and detachment of the glenoid labrum, associated with stripping of the anterior part of the capsule, is a major causative factor. The other causative factor is a deformity of the articular surface of the head of the humerus. This defect is posterolateral and is best shown in roentgenograms made in the anteroposterior projection with 60 to 70 degrees of internal rotation. In the position of internal rotation the defect is demonstrable in the upper outer margin of the head of the humerus and is indicated by a dense line of condensation extending down from the top of the humeral head parallel with the shaft. The author feels that possibly the detachment of the labrum occurs first and that subsequent impacts against the unprotected bone margin of the glenoid cavity cause secondary flattening of the humeral head.

Five forms of trauma are given in which the mechanism of the production of the initial dislocation is known. These are: (1) fall on the abducted arm; (2) a direct blow from behind, acting on the head of the humerus; (3) hyperextension of the abducted arm; (4) excessive

internal rotation in abduction; (5) inferior dislocation.

An analysis of the surgical corrective procedures is presented and the results obtained by using the Nicola, Bankart, and Putti-Platt operations.

JOHN R. HODGSON, M.D.

[This is one of a series of articles on recurrent shoulder dislocation in the British number of the Journal of Bone and Joint Surgery. Another of the group is abstracted below.]

**The Bone Block Method for Recurrent Dislocation of the Shoulder Joint.** Ivar Palmer and Anders Widén. J. Bone & Joint Surg. **30B:** 53–58, February 1948.

The bone block method or Hybbinette-Eden operation for recurrent dislocation of the shoulder joint has been widely used in the Scandinavian countries. The procedure involves the making of a subperiosteal pocket at the lower part of the anterior glenoid rim. Into this pocket a graft is inserted so that its projecting part is lodged on the rim forming an anterior wall of bone.

The authors present an analysis of the findings and results in 60 cases treated by the bone block method. All of the cases were examined radiographically before operation and each showed a typical compression fracture of the posterior part of the head of the humerus. In 27 cases typical detachment of the labrum from the anterior glenoid rim was found at operation. In 2 cases the labrum was detached from the rim and from the capsule and dislocated into the joint. In 22 cases the labrum either was ruptured or was absent from the lower anterior rim. In 5 cases there were only slight changes on the edge of the labrum, and in 4 cases it was not possible to find any pathological abnormality at all on the anterior rim.

Results of the operation were excellent. Eleven patients reported only slight restriction of movement. There were 4 postoperative recurrences, but in all cases the trauma leading to recurrence might well have produced dislocation in a previously normal shoulder.

The authors feel that the essential lesion in recurrent dislocation of the shoulder is not the detachment of the anterior glenoid rim, but rather the deformity in the posterior part of the humeral head, which results in the loss of adhering force between the head and the joint cavity. This produces an unstable joint. As the anterior rim of the glenoid slides into its hollow in the humeral head, the head slides forward, and only a strong anterior support would be able to prevent dislocation.

The authors conclude that recurrent dislocation is in reality an intracapsular subluxation which occurs when the anterior rim of the glenoid slides into the hollow in the humeral head. JOHN R. HODGSON, M.D.

**Calcification of the Supraspinatus Tendon: Infiltration Therapy with Local Anesthesia and Multiple Needling.** I. Norwich. Surg., Gynec. & Obst. **86:** 183–191, February 1948.

The anatomical relationships of the subacromial bursa and the musculotendinous cuff of the short rotators is discussed. Most pathological lesions of these structures result from either acute or chronic trauma, and both the bursa and the cuff are involved. The tendon is subject to degeneration, rupture, and calcification, and the bursa to acute and chronic bursitis. The various opinions regarding the etiology and pathogenesis of calcification in the tendon are reviewed, and it is pointed out that there seems to be some relation to occupation. The calcium deposit is attributed to a decreased carbon dioxide content and consequent increased alkalinity of the blood which renders the inorganic calcium carbonate and phosphate solution unstable and accounts for the gradual deposition.

The repeated trauma of abduction of the shoulder, with impingement of the tendon under the acromial process and the coraco-acromial ligament, leads to degeneration and/or calcification in the tendon. Acute or chronic symptoms may result in such a situation, with sudden major or minor abduction producing rupture of the fibers or rupture of the calcareous deposit into the bursa, leading to bursitis. Symptoms and diagnostic criteria are discussed. All suspected cases call for roentgen examination, including spot films. The deposit must be seen in profile or it will be obscured by the underlying bone.

The author describes in detail the treatment that he has employed for the past five years for the acute symptoms produced in association with supraspinatus calcification. This consists of local anesthetic infiltration of the calcification and multiple needling of the deposit, followed by immediate and continuous movement of the affected shoulder. The rationale of this therapy is as follows: the local anesthetic relieves the pain, thereby permitting motion, resulting in the production of hyperemia, which thus aids in the reabsorption of the calcium. In addition, by needling the deposit, the soft calcification is disseminated into the tissue spaces, thus being more rapidly absorbed.

It is stated that 15 patients have been treated with great success by this method, and have been followed for periods varying from seven months to four years. Seven cases are presented in summary. Complete relief of symptoms was obtained in all, without recurrence during the follow-up periods. X-ray examinations of the shoulders in these cases showed disappearance of the calcium deposits within an average interval of three to four weeks. All of the patients had had acute symptoms, with demonstrable calcification. Some were treated in the initial episode of pain; in others, there was a history of previous chronic shoulder pain. No statistics are presented to indicate failures of therapy, if such occurred, though the author states that failures may be due to inadequate infiltration and needling of the deposit, and to lack of immediate and daily motion of the shoulder joint. D. B. NAGLE, M.D.

**An Anatomical Study of the Mechanics, Pathology, and Healing of Fracture of the Femoral Neck. A Preliminary Report.** Aladár Farkas, Milton J. Wilson, and J. Clifford Hayner. J. Bone & Joint Surg. **30-A:** 53–69, January 1948.

The authors report an investigation into the problem of union and non-union of fractures of the femoral neck, including the pathology, mechanics anatomy, radiography, and surgical approach to the problem. For this purpose the softer structures within the femoral neck were curetted away to show the trabecular structure within the bone. A rather hard quadrangular bone structure is found near the base of the femoral head, in the neck, and in the region of the cartilaginous plate. If this structure were investigated from the lateral aspect after removal of the greater trochanter, it was found to lie posteriorly against the cortex and arise near the lesser trochanter, extending up to the region of the base of the femoral head on the posterior aspect of the neck. This structure is seen

both in dissected specimens and in radiographs of this bone. After middle age there is slow absorption of the trabecular structure beginning at its distal portion and extending upward toward the femoral head.

From this study it is believed that when the internal weight-bearing system is strong and healthy, fracture of the femoral neck will heal well and rapidly, while if the internal weight-bearing system has undergone pathologic change, healing with normal function is at least improbable.

In abduction fractures, the break occurs at the weakest point, that is near the middle of the neck, with the cortical shell fracturing at the cervicocapital juncture, with a wedge-shaped distal fragment and resulting impaction. Radiographic change in this type of fracture shows the laminae to be numerous and densely packed, with the proximal fragment of the internal weight-bearing system quite long.

A new method of bone graft (perforated, or sieve, sublay graft) in the treatment of fracture of the femoral neck is mentioned. JOHN B. MCANENY, M.D.

**Disturbance of Longitudinal Growth Associated with Prolonged Disability of the Lower Extremity.** Donald Ross. J. Bone & Joint Surg. **30-A:** 103–115, January 1948.

This paper discusses the premature closure of the epiphysis at the knee in patients who have had prolonged dysfunction of the lower limbs as a result of tuberculosis, pyogenic arthritis, slipped epiphysis, poliomyelitis, or osteomyelitis. Thirteen patients were studied, 6 boys and 7 girls, and their complete case histories are recorded. The site of growth arrest varied. In 5 patients the arrest occurred in both the distal femoral and proximal tibial epiphyses. In 8 patients the arrest occurred in the proximal tibial epiphysis only.

Roentgenographic evidence of epiphyseal disturbance occurs prior to the development of limb inequality or alignment deformity. The early change in the epiphyseal cartilage appears as a thinning of the epiphyseal disk with a transverse zone of dense bone on its metaphyseal aspect. The contour of the epiphyseal cartilage may be irregular and sometimes peaks project into the metaphysis. At times radiolucent defects on the metaphyseal side are seen. When growth arrest occurs, bone bridging across the epiphyseal plate is seen. In the distal femoral epiphysis the arrest usually begins in the posterocentral portion of the disk, resulting in a posterior rotation of the condyles. In the proximal tibial epiphysis, arrest occurs on the posteromedial metaphysis aspect. At times the tibial tubercle unites prematurely with the metaphysis and tibia recurvata develops. JOHN B. MCANENY, M.D.

**Isolated Fracture of the Trapezium.** A. Sobel and P. Sobel. J. de radiol. et d'électrol. **28:** 467–468, 1947.

Fractures of the trapezium (greater multangular) are rare and, when they do occur, are usually associated with other carpal lesions. The authors report a case of isolated fracture of the trapezium in a 32-year-old woman. The fracture line was demonstrated only by means of films taken in the anteroposterior (dorsal) projection. RODERICK L. TONDREAU, M.D.

**A Case of Localised Traumatic Bone Absorption in the Skull.** F. G. Nicholas, H. C. Furst, and R. Tepper. Brit. J. Radiol. **21:** 67–69, February 1948.

A two-year-old child was brought for examination two weeks following a minor injury to the head. A fluctuant mass was present in the lateral portion of the frontal bone, through which a defect in the skull could be felt. Roentgen examination showed an oval area of decalcification in the skull beneath the lump, but no evidence of fracture. The palpable mass gradually subsided and in nine months the bony defect had disappeared.

Bone absorption in the skull is rarely observed after trauma, possibly because it is not looked for, although absorption along fracture lines is frequently seen.

Three possible explanations for the phenomenon are offered: the absorption is secondary to a traumatic meningocele; it may follow a subpericranial hematoma; or it may be due to an aseptic necrosis.

SYDNEY J. HAWLEY, M.D.

**On the Technic of Lumbar Pneumomyelography.** Olle Olsson. Acta radiol. **29:** 107–111, Feb. 28, 1948.

The author sets forth [with some exaggeration] the disadvantages of opaque media in myelography for the diagnosis of lumbar disk prolapses, and describes a new technic with the use of oxygen. This is based on the procedure of Busch (Acta radiol. **22:** 556, 1941) and Lindgren (Acta chir. scandinav. **82:** 303, 1939), with certain modifications to improve the contrast, lessen the time required for the examination, and avoid subsequent ill effects. Two Lysholm grids are used, at right angles to each other. The patient is examined on a simple wheeled stretcher, lying with the suspected side up. The x-rays are directed horizontally. Fluoroscopy apparently is not used. The method is simple and seems worthy of trial. ZAC F. ENDRESS, M.D.

**Myositis Ossificans Progressiva in Homozygotic Twins.** Jacob H. Vastine, II, Mary Frances Vastine, and Oriol Arango. Am. J. Roentgenol. **59:** 204–212, February 1948.

Myositis ossificans progressiva, which should more appropriately be designated "fibrositis ossificans progressiva," was discovered by the authors in homozygotic twins. The distribution of the lesions in the two girls was strikingly similar. In both there was ossification posteriorly in the cervical region and in the subcutaneous tissues of the back. In one there was much more extensive ossification about the hip joints and upper femora than in the other. The phalanges of the great toes were fused in both and both showed hallux valgus with deformities of the distal ends of the first metatarsal bones.

Heretofore, the etiology of this malady has been questionable. With the evidence at hand, the authors suggest that a strong genetic influence is probably involved. Roentgenograms and photographs are reproduced.

JAMES C. KATTERJOHN, M.D.

## GYNECOLOGY AND OBSTETRICS

**An Unusual Case of Infection of a Sixteen Weeks' Extra-uterine Pregnancy.** John L. Boldero. J. Obst. & Gynaec. Brit. Emp. **55:** 47–49, February 1948.

A brief account is given of an unusual case with evidence of infection following repeated attempts at abor-

tion. The first x-ray examination, Oct. 19, 1945, revealed a fetus of four or five months. There was at that time a hard, nodular tumor arising from the pelvis, situated for the most part toward the right side of the abdomen, tender and fixed to the deeper structures. A second roentgen examination, Nov. 2, showed the fetus entirely surrounded by gas, with evidence of gas in the skull. Since the fetus was believed to be lying *in utero*, an attempt at evacuation by way of the vagina was made. The cervix was dilated but the uterus proved to be empty and a perforation was discovered in the anterior wall of the cervical canal. Laparotomy was then performed and the pelvic mass was found to be a large abscess sealed off by adhesions, containing the fetus and a considerable amount of foul-smelling pus. The fetus was removed, the abscess cavity was drained, and the patient eventually made a good recovery.

A review of the case indicated that the patient had a ruptured ectopic gestation, with subsequent death of the fetus. A low-grade pelvic peritonitis followed perforation of the cervical canal, and infection converted the amniotic sac into an abscess cavity.

The roentgenographic reproductions are excellent and illustrate clearly the state of affairs prior to operation. It is of interest that a fecal fistula developed following operation, but closed spontaneously.

SYDNEY F. THOMAS, M.D.

## THE GENITO-URINARY SYSTEM

**Significance and Value of Functional Urographic Images and Signs.** Richard Hickel and Paul Cornet. J. de radiol. et d'électrol. **29:** 9–17, 1948.

Excretory urography furnishes information of morphologic and functional value. At the onset of a renal disease, when function is still normal or when the difference between the two kidneys is negligible, the functional signs of urography are of no interest. In the advanced disease, however, particularly when the question of surgical intervention arises, the functional tests assume great importance.

The authors state that, in order to obtain urograms of the highest diagnostic quality, so that both the morphologic and functional signs may be properly evaluated, it is necessary to prevent the urine from flowing into the bladder. The only way to accomplish this is by early abdominal compression, that is, within sixty to ninety seconds after intravenous injection of the dye. In a large number of cases studied by the authors, results of renal function as determined by excretory urography paralleled those obtained by division of the urine.

Functional urographic *signs* are: delayed appearance of the image of the renal pelvis; insufficient density of the pelvic silhouette, and absence of the pelvic image. Functional urographic *images* include incomplete demonstration of the pelvic tree, pre-papillary shadows, and nephrography. Thus, disorders of renal excretion are manifested by varied images and signs which demonstrate the existence of urine under pressure in the involved urinary tract. The same kidney can present signs which indicate impairment of both secretion and excretion. When the pre-papillary shadows are "ball-like" in shape, one can expect to find disorders of secretion as well as excretion. The appearance of spontaneous or artificial nephrography indicates that the kidney is not destroyed at all, or that its destruction is incomplete. RODERICK L. TONDREAU, M.D.

**Medial Ptosis of the Kidney.** George C. Prather. New England J. Med. **238:** 253–257, Feb. 19, 1948.

Because of frequent negative findings in patients with clinical suggestion of renal disease, the author considered the possibility of lateral mobility of the kidneys as a potentiality. In several patients this possibility was investigated.

After the usual retrograde pyelographic studies, where lateral mobility of the kidney was thought to be a possible feature, the patient was turned with the suspected side uppermost. A radiograph in this position showed the outline of the urinary tract and by comparison with the routine films lateral mobility could be shown.

In a control series no medial mobility of the urinary tract could be demonstrated in the normal kidney.

It is believed that medial descent of the kidney may explain some of the undiagnosed symptoms referable to the renal region or upper abdomen. Nephropexy will correct this condition. JOHN B. MCANENY, M.D.

**Extreme Renal Displacement due to Retroperitoneal Tumors.** Laurence F. Greene. J. Urol. **59:** 174–178, February 1948.

The author presents 3 cases in which the kidney was displaced to the opposite side of the abdomen by a benign retroperitoneal mass. In each case, the displaced kidney was shown roentgenographically to be superimposed upon the other kidney and rotated to some extent as well. There was no impairment of renal function as indicated by intravenous urography. Following operative removal of the tumor, the kidney returned to its normal position in each case.

Schulte and Emmett (J. Urol. **42:** 215, 1939) are quoted as having found renal displacement in 72.5 per cent of a series of retroperitoneal tumors (excluding tumors of the pancreas). HORACE G. BUTLER, M.D.

**Cavernous Hemagioma of the Kidney.** Alan J. Chenery and Alfred H. Benson. J. Urol. **59:** 164–166, February 1948.

The author reports a case of cavernous hemangioma of the kidney. In view of gross hematuria and pyelographic demonstration of a small filling defect in one of the minor superior calices of the right kidney, a diagnosis of renal tumor was made and nephrectomy was done. The benign nature of the lesion was discovered on histologic study. The author points out that the only manner in which a diagnosis of benign renal tumor can possibly be made is by a history of repeated hematuria over a period of several to many years, with minimal pyelographic findings, and the presence of none of the advanced signs of malignancy. Even then, unless one has had a previous pyelogram for comparison, one could not be sure that the pyelographic defect was not of recent development.

It is suggested as a possibility that many so-called cases of essential hematuria would be found to be due to hemangioma if all renal tissue was thoroughly examined at autopsy. Due to the insignificant size of this lesion, it is readily overlooked in routine postmortem examinations. RICHARD C. RIPPLE, M.D.

**Simple Cyst of the Renal Pelvis: Diagnosis and Treatment with Case Presentation.** Vincent J. Oddo. J. Urol. **59:** 159–163, February 1948.

Despite the fact that over 100 cases of renal cystic disease have been reported, the author was able to find, up

to 1946, but two reports of cysts of the renal pelvis. One of the patients was a male, aged 35 years, with a cyst at the upper pole of the left renal pelvis, containing two calcific masses (Loeb: Urol. & Cutan. Rev. **48:** 105, 1944). A heminephrectomy was performed with a good recovery. Diagnosis was made by retrograde pyelography. The second case (Lowsley and Curtis: J. A. M. A. **127:** 1112, 1945) occurred in a female, aged 58 years. A firm, non-tender mass was palpable and a diagnosis of neoplasm of the right kidney was made. On operation, several large renal cysts were found. One small cyst was connected with the lower portion of the renal pelvis.

The etiology of renal cysts is unknown. One theory is that they are a form of localized polycystic disease of the kidney. A second is that they form as a result of the failure of the uniniferous tubule to unite with the collecting duct. A third view is that they grow and develop from an anlage of a fetal cyst, whereas a fourth opinion is that they are acquired as a result of localized tubular blockage.

The diagnosis can usually be made quite readily from the urologic examination. In renal cysts the mass extends outward from the substance of the kidney, while in renal pelvic cysts, the mass extends outward from the pelvis through the parenchyma and cortex. In all cases the patient will eventually complain of an ache or pain in the affected kidney. Intravenous or retrograde pyelography will demonstrate a change in pelvic outline or a filling defect just above one of the calices.

The author presents a case occurring in a 32-year-old male who complained of a pain in the right costovertebral angle of eight years duration. The diagnosis was made by intravenous urography, which showed a cyst arising from the right upper calyx of the pelvis. A tubule was demonstrated extending upward from the papilla into the cystic cavity. At operation the cyst was dissected from the kidney, bleeding being controlled by a rubber tourniquet applied to the pedicle. Six months following operation, an intravenous urogram showed the kidney to be normal in size, shape, and position.

JOHN W. HOPE, M.D.

**Safety Factors in Prostatic Surgery.** William J. Engel. Pennsylvania M. J. **51:** 512–520, February 1948.

The most important single examination contributing to the safety of prostatic surgery is intravenous urography. "As a test for renal function it may be relied on to the exclusion of all others." X-ray exposures should be made five, fifteen, thirty and sixty minutes after administration of diodrast. The findings on these films will be as accurate as the urea clearance test.

The average normal kidneys will excrete 45 per cent of diodrast in the first thirty minutes. Good visualization in fifteen minutes indicates excellent renal function. The patient is considered a satisfactory surgical risk, however, if visualization is good in 30 minutes, or even in an hour, when no evidence of back pressure is seen.

The type of obstruction, upon which selection of operation depends, can be determined from the interpretation of the cystogram. A fibrous contracture will produce a transverse crescentic shadow across the bladder. It is generally agreed that transurethral resection is the method of choice in such cases. Intravesical hypertrophy, which occurs especially in the medial lobe, is shown on the x-rays as a spherical deformity extending into the bladder. The choice of operation here depends largely on the size of the prostate and experience of the surgeon. In the subvesical type of enlargement the entire bladder base is pushed up and the lower ends of the ureters have a fish-hook appearance. Under these circumstances, prostatectomy is the operation of choice for any gland whose estimated weight exceeds 70 gm.

From the cystograms, therefore, we can determine with reasonable accuracy the size and type of prostatic hypertrophy without subjecting the patient to the hazards of cystoscopy. Where drainage must be used, a suprapubic puncture is considered the method of choice.

The operation itself is considered by the author to be the least important of all the procedures. The three dangers after surgery, namely shock, hemorrhage, and uremia, have been largely prevented by a satisfactory preoperative work-up, skilled anesthesia, proper operating technic, and control of infection by the antibiotics.

JOSEPH T. DANZER, M.D.

## TECHNIC

**Screen Photography Equipment for Easier Detail Photography with Routine Roentgen Diagnosis Work.** Carl Wegelius and Kaj Noschis. Acta radiol. **29:** 101–106, Feb. 28, 1948.

To overcome the disadvantages of the present form of screen photography (bulky special apparatus and over-reduction of the visible image), as well as to conserve film, the authors have ingeniously adapted a 35-mm. camera for spot filming. The reduction is 1:5, very near the ratio in photofluorographic chest films, which have proved so valuable. The photographed area of the screen measures 12 × 12 cm. The exact exposure factors are not given, but are said to be the same as for ordinary spot-film work. One assumes that the same type of film is used (blue or green sensitive, depending on the screen). The camera is not attached to the table but is suspended from the ceiling, so that it is easily available for horizontal or vertical work and is out of the way when not in use.

Reproductions of films made with this apparatus, called by the authors a "Wegnograph," appear to show good detail.

ZAC F. ENDRESS, M.D.

**Foreign Body Localization in the Soft Parts: A Simple Method Requiring No Especial Training or Equipment.** Clarence E. Gardner, Jr. Surgery **23:** 275–277, February 1948.

A method of foreign body localization is described. It consists of insertion into the tissue of two long slender needles at right angles to each other, in such a fashion that they cross the approximate location of the foreign body. Anteroposterior and lateral roentgenograms are obtained, and surgical approach is planned on the basis of the relation of the needles to the foreign body. If, at operation, there is difficulty in locating the foreign body, the needles are reinserted and a second pair of films is made. This second procedure is necessary only when the needles become loosened in the tissues during the dissection and no longer act as fixed points. A case report concerns a broken thoracentesis needle which was located and removed from the chest by this method.

The procedure is recommended because of its simplicity, requiring no special equipment or training. It is similar to that of Hotchkiss (Virginia M. Monthly **71:** 37, 1944. Abst. in Radiology **43:** 314, 1944), to which the author refers.

J. E. WHITELEATHER, M.D.

## RADIOTHERAPY

**Medulloblastoma Cerebelli. Diagnosis, Treatment, and Survivals, with a Report of Fifty-Six Cases.** Franc D. Ingraham, Orville T. Bailey, and Wiley F. Barker. New England J. Med. **238:** 171–174, Feb. 5, 1948.

This is an investigation into the results obtained with various forms of treatment in medulloblastoma cerebelli. A series of 56 cases was studied. Fifteen of these tumors did not occur in the classic midline position in or above the fourth ventricle. Twenty-four of the cases were seen in the second five years of life and 42 were seen in the first decade, but typical tumors were also seen as late as thirty-six years. The onset of symptoms is usually rapid but not necessarily so. There is evidence of increased intracranial pressure and disturbance of cerebellar function. Since other tumors may cause similar effects, biopsy is necessary for definite diagnosis.

Experience has shown that x-ray therapy is by far the most effective treatment. Thirty-nine of this group of 56 patients received irradiation therapy; 6 patients received an undetermined amount of irradiation and survived, on an average, 7.4 months. Nine patients received between 150 and 2,850 r with an average survival time of 7.6 months. Fifteen patients received between 4,500 and 9,600 r with a symptom-free period of twenty-four months and an average survival of 31.6 months. Those receiving between 10,000 and 30,000 r had an average symptom-free period of 44.6 months and an average survival of fifty-four months.

The causes of death in patients with cerebellar medulloblastoma include increased intracranial pressure, edema, shock, postoperative hemorrhage, meningitis, and metastases.

If at operation a large amount of tumor can be removed with safety, this is done. Otherwise a biopsy is taken and as soon as the wound is healed, the patient is given irradiation therapy, to the region of the tumor and also to the spine in an attempt to destroy possible metastatic seeding. JOHN B. MCANENY, M.D.

**Radium Treatment of Cancer of Orbit and Ethmoid Cells.** M. Onsi Abdeen. Arch. Otolaryng. **47:** 185–188, February 1948.

A case in which radium was used in cancer of the orbit and ethmoid cells, with apparent cure, is reported chiefly to show what may be accomplished with patience and a limited amount of radium. The patient, aged 30, was admitted to the University Hospitals, Alexandria, Egypt, with a foul-smelling fungating mass at the site of the left orbit, extending beyond the midline near the inner canthus of the right eye, upward to the hairline on the left side, downward to the level of the upper lip, closing the left nostril, and backward to a point midway between the outer canthus and the tragus of the left ear. The inside of the nose was filled by a friable mass. The left pre-auricular and submaxillary lymph nodes were enlarged and hard. The histologic diagnosis was alveolar carcinoma, probably arising from one of the salivary or lacrimal glands.

Only two tubes of 50 mg. radium were available. To distribute the radiation most evenly, a cradle 6 cm. in diameter was made of iron wire, similar to an anesthesia mask. The two radium tubes were hung in the dome of this, the distance from the tubes to the surface of the tumor being 3 cm. The cradle was covered with a lead sheet to prevent the radiation from going beyond its circumference. The area of the tumor was divided into segments, each the size of the circumference of the cradle, and the appliance was placed on one segment of the tumor for twenty-four hours, then moved to another and so on until the whole tumor had been irradiated. This technic was repeated again and again, with slight differences in time of exposure according to the reaction until the mass disappeared, without producing any severe reaction. Sometimes treatment was interrupted because the radium was needed for other patients. The whole treatment took thirty-seven days of exposures. Five months after admission the patient left the hospital, to all appearances cured. He was not seen again, but a year later reported that there was no recurrence of the growth.

**Roentgen Therapy of Glioma of the Retina.** K. Velhagen. Strahlentherapie **76:** 442–448, 1947.

The author discusses briefly the present status of roentgen therapy in retinal glioma. The doses used by various radiologists differ considerably; in some of the cases reported as cured they have fluctuated between 1,500 and 4,800 r. The work of Martin and Reese (Memorial Hospital) is quoted, although the author had access only to their paper published in 1936.

Two cases are reported. In one a total of 3,500 r were given during a period of thirteen months and the patient was observed for four years without recurrence. In the second case the right eye was removed because of massive involvement by glioma. A tumor of the same type in the left eye was treated with roentgen rays and given a total dose of 4,370 r over a two-year period (180 kv., 0.75 mm. Cu). Seven years after the first visit no recurrence was seen in the left eye but a recurrence had developed on the right, with invasion of the bone. This was treated by operation and irradiation but no further follow-up was available.

ERNST A. POHLE, M.D., Ph.D.

**Radium Therapy of Malignant Tumors of the Larynx.** Rosario Impallomeni. J. de radiol. et d'électrol. **29:** 37–40, 1948.

The authors report 107 cases of malignant tumors of the larynx treated at the Italian Radiotherapy Institute of Florence. Forty-nine cases were seen between 1941 and 1945. Follow-up reports are given for 58 cases which had been previously reported by Torrigiani and Palumbo and Palumbo and Paoletti.

Laryngeal tumors are divided into three groups:

*Stage I:* Limited to the vocal cords, with no clinical involvement of cervical nodes.

*Stage II:* Extra-cordal lesions and lesions which, while arising from the cords, partially invade the remainder of the larynx, but with no cervical node involvement.

*Stage III:* Extensive tumors tending to involve the hypopharynx, invariably showing metastases in the cervical nodes.

Stage I lesions are treated by application of four radioactive units to the neck (two for each side). Each unit consists of a brass box, 5 by 6 cm., divided into five sections 1 cm. apart, in each of which is placed a 10 mg. tube of radium, that is, 50 mg. for each unit. The total is thus 200 mg., with filtration equivalent to 4 mm. Pb.

The focal distance is 6 cm. Stage II and III lesions are treated by application of 8 radioactive units (4 for each side). The unit is applied for twenty-four-hour periods alternating with twenty-four-hour rest intervals. In general, treatment requires twenty to thirty days. The total dose at the skin surface for each 50-mg. unit is at a maximum of 6,000 r, fractionated into daily doses of 600 r.

In the group of 58 cases treated before 1941, there were 57 epitheliomas and 1 case of sarcoma of the larynx. Because of the war, survival was ascertained in only 10 cases. Even this represents a survival rate of 17.5 per cent from six to eleven years after treatment. The patient with sarcoma of the larynx was still living six years after therapy.

Forty-nine cases were treated from 1941 to 1945. Five year results were obtainable in 15 cases. Four patients (26.6 per cent) were alive at the end of five years. RODERICK L. TONDREAU, M.D.

**Rhabdomyosarcoma: Case Report with Response to Roentgen Therapy.** Stuart J. Eisenberg. Virginia M. Monthly **75:** 27–28, January 1948.

The scant literature on rhabdomyosarcoma offers no clear evidence as to the response of the tumor to irradiation. In general, radioresistance is held to be the rule. The author, however, reports a case in a 13-year-old Negro male in which a rhabdomyosarcoma in the region of the left hip proved to be radiosensitive.

The hip had been injured one year previously, and the patient had been treated for a slipped femoral epiphysis. At the time of the initial diagnosis of neoplasm, a roentgenogram of the chest was negative for metastases. X-ray therapy was given to the hip through two 20 × 20-cm. portals with the following factors: 200 kv.p., 20 ma., 50 cm. target-skin distance, Thoraeus filter, half-value layer 1.0 mm. Cu. The dose was 2,400 r in air at 200 r per day [whether to each or both portals is not specified]. One year later, the boy returned with anterior chest pain, dyspnea, orthopnea, ankle edema, and a hemoglobin of 58 per cent. Extensive bilateral pulmonary and mediastinal metastases, with right pleural fluid, were present. After removal of 500 c.c. of bloody fluid by thoracentesis, the chest was irradiated through anterior and posterior 20 × 20-cm. portals, for a total of 1,000 r to each.

The patient's condition was so poor that no hope was held for his recovery. Five months later, however, he looked well and had no complaints. He was attending school and playing to the limit of his disability—a slightly shortened left leg. Two small nodules remained in the lower portion of the right lung. Further x-ray therapy was given to the chest (650 r anteriorly and 450 r posteriorly) at that time and one month later (600 r anteriorly and 400 r posteriorly). Three months after this, the general condition was unchanged, but a mass had appeared in the left lower rectus sheath of the abdomen. This was removed surgically; the microscopic picture was identical with that of the original tumor. X-rays of the chest and hip showed no further tumor growth, with only a single nodule, 3.5 cm. in diameter, at the right cardiophrenic angle. Twenty-three months after the original diagnosis, the patient's physical condition was good and he had no complaints. Roentgenograms obtained before and after irradiation are reproduced. Unfortunately, no calculation of tumor dose is given. J. E. WHITELEATHER, M.D.

**Treatment of Cervix Carcinoma with Radium and 800 Kilovolt X-Ray.** Herbert E. Schmitz. Am. J. Obst. & Gynec. **55:** 262–268, February 1948.

A series of 166 cases of primary carcinoma of the cervix was treated with higher-voltage x-ray therapy and a comparison was made with earlier results with lower voltages. The clinical classification was found to be of greater prognostic value than microscopic grading. It is the author's policy to treat all cases by irradiation, reserving the Wertheim operation for refractory cases. None of the present series was subjected to subsequent surgery because of recurrence.

By means of a measuring frame, an exact outline of the pelvis was obtained. The tumor depth was calculated and the number of fields determined in order to attain an x-ray tumor dose of 4,000 r. This was accomplished usually *via* two 20 × 20 cm. fields, one anterior, the other posterior, using 800 kv., with proper filtration. Although the patients experienced severe discomfort at the height of the irradiation effect, little permanent injury to the normal pelvic structures resulted.

Radium therapy was used in conjunction with x-rays in all cases of the first three clinical groups. Fifty milligrams of radium, properly filtered, was placed in the cervical canal for thirty hours, the application being repeated at weekly intervals for a total dose of 4,500 mg. hours.

The percentage of five-year "good end-results" in the present series was 43.37, in comparison with 28 per cent in an earlier series receiving lower-voltage roentgen therapy but similar radium treatment.

Dr. C. Behney, in his discussion of this paper, commented on the value of high-voltage therapy in transvaginal treatment, and the necessity for irradiation being pushed to the limit of tolerance regardless of histologic type or tumor size. Transvaginal therapy had not been used by the author because of technical difficulties. FREDERICK GILMORE, M.D.

**Analysis of Technical Factors and Results of Treatment in Carcinoma of the Cervix Uteri. Description of Improved Radium Applicator.** G. E. Richards. Am. J. Roentgenol. **58:** 783–796, December 1947.

This is a report of all cases of carcinoma of the cervix uteri seen at the Ontario Institute of Radiotherapy (Toronto General Hospital) from 1929 to 1940. The total number of cases was 842 and the five-year survival figures are as follows: Stage I (total 92 cases) 74 per cent; Stage II (277 cases) 50.5 per cent; Stage III (335 cases) 26.8 per cent; Stage IV (158 cases) 4.9 per cent. The author discusses and compares the results of the best surgical clinics and the best radiotherapy clinics and concludes that the evidence is in favor of radiotherapy. He points out that radiation therapy is still making favorable progress, as shown by improvement in the survival rates over earlier reports.

A new type of radium applicator is described, which is believed to offer certain advantages in technical application of radium to the cervix. There is considerable discussion of the methods of calculation of the "tumor dose" as used at the Ontario Institute of Radiotherapy. The necessity of careful dosage control and adequate dosage within the pelvis is pointed out. Systems used for control and follow-up of the patient are described and illustrated.

G. K. VOLLMAR, M.D.

**End-Results in the Treatment of Carcinoma of the Cervix.** H. Köhler and F. Haenisch. Strahlentherapie **76:** 342–360, 1947.

The authors analyzed 582 cases of carcinoma of the cervix observed in the Gynecological Clinic and the Radiation Institute of the City Hospital of Barmbeck from 1927 to 1938; 530 patients were actually treated and 52 were not. Of those treated, 315 were operated on and irradiated and 215 were treated by radiation alone. In 275 of the operated cases, the surgical technic of Bumm-Wertheim was followed. All patients in this group received postoperative roentgen therapy.

Of the treated patients, 349 belonged to Groups I and II; 34 of these were treated by radiation alone, as were all the 181 patients belonging to Groups III and IV. The authors' approach, therefore, was to carry out radical operation in as many patients of Groups I and II as possible. The operative mortality was 6.3 per cent, and the entire operation did not consume more than one hour to one hour and a half. Preoperative radium therapy has been discontinued.

The absolute cure rate for the operated cases was 36.6 per cent for the period from 1927 to 1931 and 46 per cent for the period from 1932 to 1938. The respective figures for the irradiated patients were 3.7 per cent and 24.4 per cent. It is emphasized, however, that 84.2 per cent of the irradiated patients belonged to Groups III and IV.

In the first observation period, the technical radiation factors were as follows: 145 kv., 0.5 mm. Cu + 1.0 mm. Al, 40 cm. focal skin distance; usually treatment was given to two anterior and one posterior field and also by intravaginal cone. The surface dose amounted to 650 r. Such a series was repeated after three months, and sometimes a third series was given after another six months. After 1932 the technic was changed: 185 kv., 0.5 mm. Cu + 1.0 mm. Al, 40 cm. distance, half-value layer equal to 1.05 mm. Cu; two abdominal fields, two upper posterior fields, two fields over the buttocks, and one perineal field were treated. The single dose amounted to 512 r per field, and the total surface dose to 2,560 r per field, except for the perineal area, which received 429 r as a single dose and 1,287 r as total dose. The authors calculated that the total dose effective in the cervix amounts to 3,689 r.

Radium therapy was carried out by the method used at the Radiumhemmet in Stockholm: 90 mg. of radium packed against the cervical os and also applied intracervically for twenty-two hours. This was repeated after eight days and once more after three weeks. While the total dose varied with the individual patient, an attempt was usually made to reach a total dose of 6,000 mg. hours.

The tabulation of the final end results showed that of the 582 observed cases, 248 were well after five years, which corresponds to an absolute cure rate of 42.6 per cent. It is interesting to note that only one case was lost sight of before the five-year observation period had elapsed. It was the authors' practice to examine their patients every three months for five years and then once a year for the next five years. It appeared that among 200 patients surviving five years after operation and irradiation, late recurrences occurred only twice after nine years. Among the 48 patients cured by irradiation, there were likewise only 2 late recurrences, one after nine and one after ten years. Both cases were of the advanced stage, Group III.

ERNST A. POHLE, M.D., Ph.D.

**Carcinoma of the Cervix Complicating Procidentia Uteri.** Dorothy L. Ashton. Am. J. Obst. & Gynec. **55:** 299–301, February 1948.

Only 2 examples of carcinoma of the cervix complicating procidentia were found among 274 cervical cancers seen in the last fifteen years at Woman's Medical College Hospital of Pennsylvania. A survey of the literature yielded only 78 similar cases. The rarity of this complication is explained primarily by the protective cornification of the prolapsed epithelium, which apparently raises the resistance to cancer.

As to treatment, the accepted procedure is deep x-ray therapy first, which frequently combats infection and causes shrinkage of the tumor, permitting replacement of the uterus. This is followed by local radium application and surgical extirpation as indicated. One of the author's patients had a recurrence seven years after her original treatment in 1931, was again treated by radium, and was alive at the time of the report. The other died, presumably with lymph node involvement, before treatment could be completed.

FREDERICK GILMORE, M.D.

**Use of Multiple Sources of Radium Within the Uterus in the Treatment of Endometrial Cancer.** A. N. Arneson, William W. Stanbro, and James F. Nolan. Am. J. Obst. & Gynec. **55:** 64–75, January 1948.

About 1938 a planned technic of therapy for endometrial cancer was established at the Barnes Hospital and Barnard Free Skin and Cancer Hospital. This technic, subsequently modified in various respects, calls for multiple capsules of radium packed individually into the uterine cavity, in an attempt to fill all available spaces. Radium application is preceded by external irradiation. The same technic is employed in inoperable cases and as a preoperative measure. Between 1936 and 1941, 93 patients were treated, of whom some 45 per cent were considered inoperable. This latter group of patients, treated solely by radiation, numbered 43, with a 27 per cent five-year survival. Of 32 patients treated by radiation plus hysterectomy, 68 per cent were alive and well after five years. Eighteen patients were treated by surgery alone and of these 84 per cent are alive and well, a result attributable to the selection of favorable clinical material during the transition to routine preoperative irradiation. The absolute five-year survival for the entire series of 93 patients is 53 per cent. Better results were obtained in patients with more highly differentiated carcinomas.

The results of the present technic are compared with those obtained with tandems containing two or three tubes in linear arrangement. For small uteri the uterine tandems and multiple capsules appear to be equally effective. For large bulky irregular masses and irregular uterine cavities the newer method has definite advantages.

An important feature in the prognosis is the presence or absence of tumor within the uterus after preoperative irradiation. In the authors' series there was a 46 per cent five-year survival of patients undergoing hysterectomy but with persistent tumor. In patients in whom the uterus showed no remnants of tumor tissue, the five-year survival figure was 88 per cent. It is of importance to note that when tandems were used, persistent tumors were found in 70 per cent of the patients, but where multiple capsules were employed, visible cancer in the specimen occurred in only 26 per cent.

A further breakdown of the patient groups, as well as discussions of improvements of technic and distribution of the radiation in the tissues, are given in some detail. It is definitely demonstrated that higher survival rates are obtained through the use of multiple capsules than with the older tandem technic.

WILLIS E. MANGES, M.D.

**Treatment of Carcinoma of the Fundus Uteri.** Leon S. McGoogan and Howard B. Hunt. Arch. Surg. **56:** 172–177, February 1948.

This report concerns 72 patients with carcinoma of the uterine fundus seen at University of Nebraska Hospital from 1931 to 1946. Since the hospital cares for the indigent only, many of the patients were not seen until the disease was far advanced. Therapy was consequently highly individualized to meet the requirements of each case. X-ray therapy alone was used only in presumably hopeless disease. Radium therapy alone was not voluntarily chosen for any patient, although for several it was employed for various reasons, mostly non-medical.

Generally, a course of x-ray was given to deliver 2,500 to 3,000 r to the mid pelvis; two to six ports were employed, and the patient given 180 r to each of two ports daily (200 kv. constant potential, Thoraeus "A" filter, 70 cm. distance). The dose per field rarely exceeded 2,000 r. Radium application was given at intervals of ten to fourteen days, with two to four applications totaling 4,000 to 8,600 mg. hr. Filtration was 1 mm. platinum plus rubber. This technic delivers about 2,500 gamma roentgens to a zone 2 cm. from the uterine canal. Since 1937, 35 patients have been treated with a combination of high-voltage x-rays and radium; two to three months later they were re-evaluated, with a view to the possibility or necessity of surgical removal of the cancer by panhysterectomy. Nine of the group were later operated upon, as well as 1 patient who had had radium treatment only. Nine of the ten specimens were carefully studied histologically; in only 1 was evidence of residual cancer found. Of the 41 patients followed five or more years, 18 (44 per cent) survived for five years. The authors believe the possibilities of radiation followed by surgical extirpation of the uterus and adnexa should be further investigated as offering hope of a higher cure rate in fundal carcinoma.

LEWIS G. JACOBS, M.D.

**Radiation Treatment of Carcinoma of the Corpus Uteri.** Ethlyn Trapp and Margaret Hardie. Canad. M. A. J. **58:** 115–118, February 1948.

The authors report a series of 59 cases of histologically proved adenocarcinoma of the corpus uteri treated by the Heyman technic of packing the cavity of the uterus with radium capsules. The primary treatment in these 59 cases fell into the following groups: 6 were treated by radium alone; 47 by radium and x-rays; 6 by radium, x-rays, and surgery. For the survival analysis, only the patients treated between 1938 and 1944, numbering 46, are considered. Of these, 31 (67.4 per cent) were alive without evidence of disease for three years or longer. Only 12 of the 31 cases had been judged to be clinically operable. Of the entire group of 59 cases, 8 died of their disease within a year, 4 of these within less than six months, 1 of hemorrhagic enteritis during x-ray treatment. All 8 cases were too far advanced for anything but palliative treatment.

**Carcinoma of the Uterus and Pregnancy.** I. M. Stutzer. Strahlentherapie **76:** 361–370, 1947.

The author analyzes 23 cases of carcinoma of the cervix developing during pregnancy. If bleeding was the first symptom, it did not alarm most of the patients. In fact, the average interval between the first hemorrhage and consultation of a physician was four months. Ninety-four per cent of all the cases were operable; this included cases with bleeding for five to eight months. It is possible that a carcinoma during pregnancy does not produce any symptoms.

In the author's experience the existence of pregnancy does not accelerate the growth of the carcinoma. While growth is rapid in young patients, it seems to be retarded by pregnancy. In untreated cases, however, there is a very rapid spread of the tumor following delivery. Early removal of the evacuated uterus is therefore imperative. In young pregnant women the percentage of recurrence is higher than in those who are not pregnant. The author recommends treatment immediately after the diagnosis has been made. Radical operation plus postoperative roentgen therapy offers the best chance for a cure. In special cases, where there is a very strong desire for offspring, radium therapy may be given a trial. If the child lives, at the time of delivery the treatment mentioned above is indicated.

ERNST A. POHLE, M.D., Ph.D.

**New Apparatus for Radium Treatment of Cancer of the Uterine Cervix.** E. P. Grenier. Canad. M. A. J. **58:** 192–193, February 1948.

The author describes a device for the application of radium in the vagina, consisting of a series of hollow corks, such as those used in colpostats, fastened together by a thread. The radium tubes are placed in the corks and these are closed with smaller corks. As the apparatus is entirely non-metallic, the danger of secondary radiation is virtually eliminated. Other advantages are ease of application, adaptability to lesions of various types, and the maintenance of a constant contact of the sources of radioactivity with the lesion and a constant distance between them, thus assuring homogeneous irradiation.

**Malignant Tumors of the Ovary.** John B. Montgomery. Am. J. Obst. & Gynec. **55:** 201–215, February 1948.

This study covers 107 proved malignant tumors of the ovary seen at Jefferson Medical College Hospital over the twenty-five-year period ending Oct. 1, 1946. Eighty-four of the tumors were primary ovarian carcinomas; 7 were secondary to uterine carcinoma; 2 were adenocarcinomas occurring in teratomas; 10 were granulosa-cell tumors; 1 a Krukenberg tumor; 1 a Brenner tumor; 2 dysgerminomas. The age range for the primary carcinomas was from sixteen to seventy-three years, with 57 per cent occurring between forty and sixty; 16.6 per cent of the patients were unmarried. Symptomatically the condition is frequently silent in the earlier stages, with subsequent abdominal enlargement, pain, nausea, and weight loss.

After emphasizing the policy of surgical exploration in all cases, the author analyzes his series in the light of the four outstanding factors generally regarded as governing the end-results in ovarian cancer; grade of malignancy; extent of the growth or operability; histologic type; influence of x-ray therapy.

The 84 cases of primary serous and pseudomucinous adenocarcinoma are classified as Grade I (low malignancy), 21 cases, with 10 patients alive without disease after five to twenty-four years; Grade II (intermediate malignancy), 23 cases, with 3 patients free from disease for five to twenty years; Grade III (high malignancy), 40 cases, with only one five-year survival (2 still alive and free of disease for less than five years). The five-year survival rate for the entire group is 20.5 per cent.

The most important factor in determining the outcome is the gross extent, or operability, of the lesion. Ten of the 19 patients with completely operable growths had survived five years or longer and 2 were alive after less than five years. Only 4 of the 30 with incompletely operable tumors lived for five years. One of the 35 with inoperable diaease was still alive after twelve years, but with extensive involvement.

The pseudomucinous adenocarcinomas proved less malignant than the serous type. The papillary cysts offered a more favorable prognosis than the solid and partly solid growths.

X-ray therapy was formerly given over four ports on alternate days for four weeks to an effective depth dose of 1,600 to 2,000 r. More recently daily treatments of 125 to 250 r (in air) have been employed, with a total minimum dose of 1,200 r per port. Under special conditions the number and size of the fields are modified. All patients have been urged to have x-ray therapy, though in Grade I cases its value is uncertain, as many patients survive five years or longer without irradiation. Two patients with incompletely inoperable Grade II tumors showed definite improvement with five-year survival following roentgen therapy, while in 7 others life was probably prolonged. Prolongation of life was also obtained in cases of Grade III. In general, therefore, it may be said that roentgen therapy was useful in prolonging life but did not offer a cure without previous complete removal of the tumor.

Dr. Frank Pemberton, in his discussion of this paper, reported 32 per cent five-year cures in a series of cases at the Free Hospital for Women in Boston, though in at least 10 per cent of the survivors active disease was still present. Of a series of 69 patients given irradiation after surgery, 27 (40 per cent) lived five years or longer, in spite of the fact that 10 of these had gross metastases at the time of operation.

FREDERICK GILMORE, M.D.

**Hodgkin's Disease, 1832–1947.** Herman A. Hoster and Mary B. Dratman. Edited by Lloyd F. Craver and Harry A. Rolnick. Cancer Research **8:** 1–48, 49–78, January and February 1948.

This review of Hodgkin's disease, covering a period of 125 years, prepared under the auspices of the Hodgkin's Disease Research Foundation, is designed to stimulate further interest and research in Hodgkin's disease and allied fields of investigation. All phases of the subject are covered, and 572 references are appended.

**Nitrogen Mustards in the Treatment of Hodgkin's Disease and Lymphosarcoma.** Milton Sherry. South. M. J. **41:** 118–129, February 1948.

The nitrogen mustard used by the authors is supplied by the Committee on Growth of the National Research Council, in treatment units. Each unit consists of four bottles of 10 mg. of methyl bis-amine hydrochloride in the form of a dry salt. The solution for intravenous injection was freshly made by adding 10 c.c. of 0.9 per cent sterile aqueous sodium chloride solution to a sterile bottle containing exactly 10 mg. of the dry salt. Injection was accomplished within five minutes after preparation of the solution because of the rapid hydrolysis which may occur, with consequent loss of efficacy. The standard single dose of 0.1 mg. per kilogram of body weight was injected into the rubber tubing of an intravenous infusion set, special attention being given to assure free and rapid flow of the infusion and rapid injection of the nitrogen mustard solution. It has been suggested by numerous investigators that in no event should more than 8 mg. be administered at one dose.

The author treated 6 patients with Hodgkin's disease, 2 with lymphosarcoma, 1 with giant follicular lymphoma, and 2 with melanocarcinoma. One patient received three courses, five patients received two courses, and five patients received one course. The longest period of follow-up has been eleven months. All of these patients except 2 had received previous irradiation therapy. The duration of the disease before institution of nitrogen mustard therapy varied from three months to twelve years. The indication for the treatment in all but one of the cases was poor response or intolerance to x-ray or the fact that the disease had become refractory to irradiation. There were two excellent and three good responses, all in patients with Hodgkin's disease. The other patient with Hodgkin's disease, who had been ill for twelve years, died several months after one course of therapy. The patient with giant follicular lymphoma gave a fair response, but in all patients with lymphosarcoma and melanocarcinoma the treatment was a failure.

In general, the nitrogen mustards have the same total effect on lymphoid cells and those of the bone marrow and on the hyperplasia of the reticulum cells in Hodgkin's disease as does irradiation therapy. Whether they have any advantages over the best possible type of irradiation therapy remains to be determined. It has been found that the mustards are capable of producing salutary effects and even therapeutic remissions in patients who have become resistant to roentgen irradiation, and some patients who were unresponsive to either irradiation or to nitrogen mustard therapy are said to have demonstrated a favorable response when the two agents were used simultaneously. As a rule, local and immediate systemic reactions would seem to be less severe after nitrogen mustard therapy than after irradiation, and dermatitis due to the latter is avoided. It must be emphasized that the margin of safety in the use of nitrogen mustard is quite narrow. The maximal tolerated dose (that which does not cause harmful hemopoietic effects) is usually not much larger than the optimal therapeutic dose.

Other investigators have reported satisfactory response in the treatment of lymphosarcoma and occasionally in chronic leukemia. The author has had no experience in the treatment of the leukemias, but it is apparent from the study of the reports of other investigators that no salutary effect has been obtained in the treatment of subacute or acute leukemias.

BERT H. MALONE, M.D.

**Roentgen Therapy of Induratio Penis Plastica.** E. Kindler. Strahlentherapie **76:** 433–441, 1947.

The author briefly describes the clinical picture of induratio penis plastica and discusses the etiology and his-

tology. Treatment has been chiefly by radium and, later, by roentgen rays. The author formerly used contact therapy with one or more fields, administering 6 × 500 r and repeating this series if necessary in two months. Because of a breakdown in the apparatus, he was compelled to use conventional deep therapy in one case which had had radium treatment elsewhere without success. The factors were 190 kv., 16 ma., 0.5 mm. Cu filtration, focal skin distance 30 cm., half-value layer 0.9 mm. Cu. Fields of 6 × 8 or 8 × 10 cm. were treated through both lateral aspects, the testes being protected by heavy lead plates. In some cases 200 r were given once a month, one area being treated each time; in another group the author used 200 r on ten successive days, alternating the two lateral fields, one field per day. The results were so satisfactory that he has continued to use this technic. Four of 8 cases were almost completely cured, 2 improved, 1 was treated incompletely, and 1 is still under observation. The 8 case histories are appended.

ERNST A. POHLE, M.D., Ph.D.

**Antibiotics in Radiation Therapy.** H. Oeser. Strahlentherapie **76:** 425–432, 1947.

The use of antibiotics in connection with irradiation is discussed. They may be used in three ways: (1) to reduce local inflammatory processes; (2) to reduce the infection in ulcerated carcinoma with pain; (3) as an adjunct in the treatment of late roentgen-ray reactions, for the purpose of reducing secondary infection. The sulfonamides have proved very effective in the author's clinical practice. He believes that the decisive factor in the beneficial effect of the antibiotics is their direct contact with the bacteria but not the concentration in the blood. Nine photographs in color, illustrating some of the cases observed, are included.

ERNST A. POHLE, M.D., Ph.D.

**Late Recurrences and Late Metastases.** H. Bade Strahlentherapie **76:** 449–467, 1947.

The author analyzed a series of 4,769 tumor cases treated five years or more before the survey was made. Late recurrences were observed as follows: 21 in 793 cases of cancer of the breast, the longest interval being twenty-five years; 10 among 663 cases of cancer of the uterus, longest interval twenty-two years; 6 in 148 cases of carcinoma of the lower lip, longest interval fourteen years; 5 in 138 cases of carcinoma of the tongue, longest interval fifteen years; 4 in 786 cases of cancer of the skin, six to nine years after treatment; 2 in 105 cases of bone sarcoma sixteen and eighteen years after treatment; 2 in 74 cases of carcinoma of the ovary after five and seven years respectively. A single instance of late recurrence or metastasis was found in 18 cases of carcinoma of the vulva, after seven years; in 35 cases of carcinoma of the penis, after six years; in 77 tumors of the parotid, after five years; in 178 cases of carcinoma of the stomach, after seven years; in 55 cases of carcinoma of the pharynx, after six years; in 59 cases of carcinoma of the base of the tongue, after five years; in 207 cases of intrinsic carcinoma of the larynx, after six years, and in 23 cases of melanosarcoma, after five years. In conclusion, the author states that out of 58 cases listed here, 55 were undoubtedly true recurrences and not new primary tumors. Only in 3 cases the differentiation could not be made with certainty.

ERNST A. POHLE, M.D., Ph.D.

## RADIOACTIVE ISOTOPES

**Artificially Prepared Radioactive Isotopes as a Means of Administering Radiation Therapy.** Edward H. Reinhard. Am. J. Roentgenol. **58:** 757–773, December 1947.

The author reviews the therapeutic uses of various radioactive isotopes, particularly radioactive phosphorus and iodine, including, also, results of experimental work on the metabolism of these latter compounds.

Radioactive phosphorus is of proved value only in polycythemia vera and the chronic leukemias. In polycythemia excellent clinical and hematologic results have been obtained. Of 43 patients treated by the author, all except 2 became asymptomatic or were markedly improved. Particular emphasis is placed on the variation in the response of different patients and the consequent variation in the required dosage.

In the acute leukemias, radioactive phosphorus is of little or no value. In chronic myelogenous leukemia it offers as good results as roentgen therapy without the disadvantage of radiation sickness. Life does not appear to be prolonged, however, to any greater extent than with conventional roentgen irradiation. From the published data, isotope treatment appears to be less effective in lymphatic leukemia than in the myelogenous type. Symptomatic relief is fess striking and significant decrease in the size of the lymph nodes and enlarged spleen and liver are not so commonly observed. Reduction of splenomegaly and lymph node enlargement are more readily obtained by x-rays.

Radioactive iodine has been used in hyperthyroidism, and the work of various investigators in this field is reviewed. An occasional thyroid carcinoma takes up radioiodine but the majority are unaffected by the isotope. [For a full discussion on the use of radioactive iodine in thyroid disease, see the symposium in RADIOLOGY for October 1948.—Ed.]

A short review is included on the use of various other radioactive isotopes, none of which has proved to be therapeutically useful. G. K. VOLLMAR, M.D.

**Functional Activity of Thyroid Tumors, Benign and Malignant, as Gauged by Their Collection of Radioactive Iodine.** Rulon W. Rawson, Janet W. McArthur, Brown M. Dobyns, Rex G. Fluharty, and Oliver Cope. West. J. Surg. **56:** 82–95, February 1948.

An attempt to correlate the capacity of benign and malignant thyroid tumors to collect radioactive iodine with the histologic patterns is reported. Thirty-five patients with nodular goiters were given 100 to 200 microcuries of $I^{131}$ from one to seven days prior to thyroidectomy. The radioactivity of each specimen was determined. It was found that the capacity of the benign tumors to collect radioactive iodine could be correlated with the degree of differentiation observed histologically. "There appeared to be a spectrum of activity with the undifferentiated tumors at the low functional end, intermediate and well differentiated tumors in the midspectrum, and hyperplastic adenomas at the functioning end." Five of 12 thyroid carcinomas

were observed to collect minimal but measurable amounts of iodine. This same degree of function was found to exist in the metastases from 8 of this group.

MAURICE D. SACHS, M.D.

**Treatment of Graves' Disease with Radioactive Iodine.** Mayo H. Soley and Earl R. Miller. M. Clin. North America **32:** 3–17, January 1948.

Thirty-three patients with Graves' disease received orally administered radioiodine ($I^{131}$) and were re-examined over periods of three months to two years. The smallest dose of $I^{131}$ which produced a satisfactory remission was 800 microcuries; the largest 9,150 microcuries. The authors' present treatment schedule calls for the administration of 2,000 microcuries initially and repetition of the dose at monthly intervals until the total amount required has been given.

Twenty-five (75 per cent) of the 33 patients had a satisfactory remission of symptoms and signs of hyperthyroidism in from one and one-half months to seven and one-half months. The remaining 8 patients either took too long to return to normal (up to sixteen months) or had not returned to normal within the period of observation (up to one year) and their treatment was classified as unsatisfactory.

Studies of specific problems of dosage, measurement of radioiodine, and its distribution in the thyroid indicate that further experience is necessary before conclusions can be drawn as to the place of this type of therapy in the treatment of Graves' disease.

**A Method of Determining the Site of Retention of Aerosols Within the Respiratory Tract of Man by the Use of Radioactive Sodium. Preliminary Report.** Timothy R. Talbot, Jr., Edith H. Quimby, and Alvan L. Barach. Am. J. M. Sc. **214:** 585–592, December 1947.

A method has been devised to measure the deposition of aerosols within the respiratory tract of man by means of radioactive sodium. The retention of an aerosol is governed primarily by the size and density of the individual particles and by the hygroscopic properties of the solution from which it is formed.

When an aerosol is labeled by radioactive sodium, the total quantity retained can be determined by (1) trapping the exhaled material and subtracting from the amount given, and (2) if the isotope is a gamma-ray emitter, a correlation can be reached by taking counts at certain locations at a given time after administration.

A glass nebulizer was used to generate an aerosol of a physiologic solution of sodium chloride containing about 100 mc. of the radioactive isotope per cubic centimeter. After the aerosol had been inhaled for a few minutes, a Geiger counter placed in the axilla indicated a considerable deposition of the radioactive material.

When inhalation and breathing time are controlled, differences in the amounts of material deposited in the lung can be shown by differences in counter readings. The method should be useful in evaluating the efficiency of various methods of nebulizing therapeutic substances.

BENJAMIN COPLEMAN, M.D.

## IRRADIATION EFFECTS

**Radiotherapeutic Eradication of Cancer with Surgical Repair of Subsequent Ulceration and Deformity.** Howard B. Hunt and Donald H. Breit. Am. J. Roentgenol. **59:** 229–249, February 1948.

The authors stress the importance of close cooperation between radiotherapists and plastic surgeons in the management of patients with malignant tumors. They believe that consultation should occur before any intensive irradiation treatment is instituted if it is likely to result in chronic ulceration which will not heal. All possible sequelae should be explained to the patient and it should be pointed out that ulceration will many times develop even with carefully controlled radiotherapy.

Various plastic surgical technics are considered in detail. Chronic ulceration and necrosis in the following anatomic sites are discussed: the hand, scalp, nose, ear, larynx, mouth and jaw, vulva, penis, and anus. Each of these areas presents a rather distinct problem and they are therefore considered separately.

If intensive therapy is given, the probable need of plastic surgical repair should be anticipated: (1) when the lesion is over 5 cm. in diameter, (2) in recurrent neoplasms previously irradiated, (3) in lesions complicated by cartilage or bone involvement, (4) in scalp lesions, especially if they measure over 2 cm. and are fixed, (5) in areas anatomically deficient in vascularity and exposed to excessive trauma, and (6) in areas exposed to maceration and contamination.

If ulcers show no improvement after three months and if any of the above factors are present, it seems desirable to institute some form of surgical repair. The advantages of surgical repair are: (1) prompt relief of pain and exclusion of infection, (2) elimination of necrotic tissue and the prevention of further necrosis, (3) exclusion of the possibility of residual neoplasm by microscopic examination of excised tissue, and (4) reduced hazard of subsequent malignant change and repeated trauma by closing the necrotic defect.

Many practical points are suggested by the authors. A few which may be mentioned are: (1) preparation and care of areas to be grafted, (2) the trial of radon ointment up to fourteen weeks, except in cases where bone is involved or there is residual neoplasm, (3) the use of electrocoagulation in destroying necrotic tissue, (4) the use of thrombin-plasma in applying split thickness skin grafts.

This article is of great practical value in that it tells the radiologist what he can expect of the plastic surgeon in treating chronic ulceration and necrosis which has followed intensive roentgen therapy.

JAMES C. KATTERJOHN, M.D.

**Two Cases of Pulmonary Fibrosis after Roentgen Therapy for Carcinoma of the Breast.** M. Ramseyer. Radiol. clin. **17:** 53–56, January 1948.

Two cases of pulmonary fibrosis attributable to roentgen therapy of breast cancer are reported. One followed irradiation of a large ulcerated carcinoma with localized infection, skin metastases, infiltration of the chest wall, and axillary node involvement, a total dose of 11,900 r (in air) being given through eight fields (180 kv., 0.5 mm. Cu, 40 cm. distance). On the completion of the series there was a severe skin reaction. Nine months later roentgenograms showed only a moderate thickening of the pleura, but at fourteen months the heart was displaced to the right and a large homogeneous shadow was present in the anterior chest. These changes were attributed to fibrosis due to irradiation.

The second patient was a man of fifty who received postoperative irradiation following operation for a carcinoma of the right breast with axillary involvement. A total dose of 15,000 r (in air) was delivered over six fields. The treatment was concluded in April 1945. Roentgenograms in July and September of that year showed displacement of the trachea and the heart to the right and an extensive fibrotic process in the right upper and middle lung field.

EUGENE F. LUTTERBECK, M.D.

**A Rare Case of Damage Caused by Roentgen Radiation.** Juraj Korbler. Radiol. clin. **17:** 29–31, January 1948.

The author reports the case of a 50-year-old physician, a tuberculosis specialist, who noticed changes on his toes for about a month. The nails were damaged, more on the left than on the right side, with marked atrophy of the adjacent skin and torpid ulcers. The physician had used a portable Phillips unit for fluoroscopy for four years. The month prior to the onset of the lesions he had done 500 fluoroscopic examinations. He had worn an apron and gloves.

The unit is described in detail, with data as to the various positions of the tube, the screen, and the distance between the opening of the tube and the operator, but no measurements are furnished which would give us information as to the amount of radiation to which the feet had been exposed.

Radiologists in the European countries are warned to observe proper protective measures when using small portable equipment for mass fluoroscopy. This type of equipment is available there in large quantities as war surplus material. EUGENE F. LUTTERBECK, M.D.

**Treatment of Chronic Ulceration after Irradiation of Plantar Wart.** Mortimer H. Shaw. Brit. M. J. **1:** 11, Jan. 3, 1948.

The plantar wart was a common cause of minor disability during the past war. Ordinarily the lesion responds readily to radiation, but due to wartime conditions, therapy records did not always follow patients and over-treatment sometimes occurred, resulting in ulcers. The author obtained cures of such ulcers by radical excision down to healthy tissue and coverage of the defect by a direct pedicled flap from the opposite leg. Two cases are briefly reported.

LOUIS BERNSTEIN, M.D.

**Vitamin $B_6$ (Pyridoxine) in the Treatment of Radiation Sickness.** Giovanni Zaccone. Radiol. med. (Milan) **34:** 84–90, February 1948.

The author has treated 39 patients with vitamin $B_6$ following the administration of x-ray therapy for various conditions. All these patients had experienced severe roentgen-ray sickness. Excellent results are said to have followed one daily injection of 25 mg.

CESARE GIANTURCO, M.D.

**The Nagasaki Survivors As Seen in 1947.** Shields Warren. Mil. Surg. **102:** 98–100, Feburary 1948.

In any consideration of the effects of ionizing radiation, it is important to distinguish between total body irradiation, such as was received by many in Hiroshima and Nagasaki, and radiation to a limited field only, as commonly employed in tumor therapy. Since about 400 r of moderately penetrating (200 kv.) roentgen radiation may be fatal to a man when delivered to the entire body, obviously any one tissue or organ will receive a relatively slight dose in those who survive exposure to total body radiation. It is very doubtful that a dose of this magnitude or less will cause permanent damage to most organs or tissues. Since hematopoietic tissue and the gonads are the most susceptible to ionizing radiation, it is here that one should look especially for the development of tumors.

A considerable number of the 1945 survivors showed disturbances of the hematopoietic tissue, as evidenced both by peripheral blood counts and by sternal marrow biopsies. In 1947 most of the survivors studied had returned to approximately normal. Three cases of leukemia, one probable case of leukemia and one of multiple myeloma have been reported among the survivors up to the present time. Including the one probable case of leukemia, this gives an annual death rate of a trifle over 2 per 200,000, not significantly different from the 1.8 per 100,000 among Metropolitan Life Insurance policy holders.

No tumors of the gonads have been reported among the survivors.

## EXPERIMENTAL STUDIES

**Comparative Susceptibility of the Lymphoid Tissues of Strain C57 Black Mice to the Induction of Lymphoid Tumors by Irradiation.** Henry S. Kaplan. J. Nat. Cancer Inst. **8:** 191–197, February 1948.

Young mice of strain C57 black were killed at successive intervals after fractional whole-body irradiation. In 15 of 28 mice lymphoid tumors developed within fifty-seven to one hundred thirty-five days after the beginning of irradiation. These tumors regularly make their first appearance in the thymus gland; their dissemination is a secondary phenomenon, with direct extension to the adjacent mediastinal soft tissues and the lungs, usually preceding histologic involvement of distant lymphoid structures.

Kaplan feels that these findings are incompatible with the theory that lymphoid tumors and the closely related lymphatic leukemias are, from their inception, systemic diseases of the lymphoid tissues. Instead, it appears that these lesions are monocentric (origin within a single organ but not necessarily from a single focus in that organ) neoplastic processes, differing biologically from other neoplasms chiefly in their greater ability to invade the blood stream, and in their striking capacity for dissemination.

Certain variables, however, such as genetic constitution, age, and type of leukemogenic agent, seem to condition the relative susceptibility of the various lymphoid structures (spleen, lymph nodes, liver) as sites of origin of lymphoid tumors EDWARD E. LEVINE, M.D.

**Aeroembolism of the Bone Marrow. An Experimental Study.** Paul C. Colonna and Everett D. Jones. Arch. Surg. **56:** 161–169, February 1948.

The authors investigated the pathology of the bone changes in aseptic necrosis in rabbits, producing the

necrosis by inducing caisson disease, *i.e.*, subjecting the rabbits to compression followed by sudden decompression. The optimum pressure was found by experiment to be 55 lb./sq. in. for five and a half hours. Higher pressures resulted in acute death of the animal. By use of this pressure followed by sudden release, "bends" was induced six times in each of the 12 animals studied. Roentgenograms were made before the start of the experiment and on its completion. The object of principal study was the pathology of the bones in the stage before roentgenographic changes appeared. The gross changes in those animals which died acutely following an induction of "bends" consisted of numerous air bubbles in the venous circulation, fat, subcutaneous tissues, mesentery, fascial planes, and mediastinum, accompanied by pulmonary congestion and cardiac dilatation. Animals killed one month after the completion of the experiment showed large cavities in the medullary canals of some of the long bones, with evidence of old hemorrhages. The cortices showed no changes.

Microscopic study in both groups was similar, showing numerous cavities in the medullary soft tissues lined with pink-staining material thought to be edema fluid. The adjacent peripheral tissues were compressed and showed scattered hemorrhages, strands of fibrin, edema, and congestion. There were no cortical changes. One animal subjected to autopsy two months after the experiment also showed the characteristic cavities in the medullary canal. These cavities are ascribed to the large nitrogen bubbles resulting from the sudden decompression. LEWIS G. JACOBS, M.D.

**Studies on the Physiology, Biochemistry, and Cytopathology of the Cornea in Relation to Injury by Mustard Gas and Allied Toxic Agents. XVI. Comparison of the Effects of Mustard, Ultraviolet and X-Radiation, and Colchicine on the Cornea.** Jonas S. Friedenwald, Wilhelm Buschke and Sylvia G. Moses. Bull. Johns Hopkins Hosp. **82:** 312–325, February 1948.

Some of the tissue reactions (mitosis inhibition, nuclear fragmentation, loosening of the corneal epithelium, increased non-protein nitrogen) to x-rays, ultraviolet radiations, and colchicine, have been compared with similar reactions to mustard. Among the agents compared, the effects of ultraviolet radiation resemble those of mustard most closely, though with definite quantitative differences and with differences in relative susceptibility among various layers of corneal epithelial cells. If the mitosis inhibition produced by x-rays has any element in common with that produced by ultraviolet rays and mustard, then the effects of both types of agents are complex, each involving some factors not shared by the other. In the case of ultraviolet radiation and mustard, there may be some connection between the factors which lead to mitosis inhibition and those which lead to nuclear fragmentation, but nuclear fragmentation was not found in the corneal cells after x-ray irradiation, in spite of the marked inhibition of mitosis. Neither mitosis inhibition nor nuclear fragmentation appears to be directly connected with the loosening of the corneal epithelium nor with the increased non-protein nitrogen content of the cornea found after ultraviolet or mustard exposure.

**Irradiation of Viruses and Bacteria.** P. Bonét-Maury. J. de radiol. et d'électrol. **28:** 463–465, 1947.

The size of viruses can be determined by irradiation. The results are in accord with those obtained by other methods, *i.e.*, filtration, centrifugation, and electron microscopy. The technic of the method is not discussed in this paper but is described in detail by the same author in the *British Journal of Radiology*, Supplement No. 1, 1947. The underlying principle is the fact that the radiosensitivity of an ultramicroscopic organism depends on its size. The larger the organism, the greater the chance of its being ionized.

The virulence of a virus is first determined by animal inoculation. Following irradiation, the virulence is again determined. From the inactivation curves obtained in this manner, the size of the organism can be calculated indirectly. It has thus been possible to measure viruses which are not visible by electron microscopy. RODERICK L. TONDREAU, M.D.

**Influence of Grenz Rays on Cell Division and Wound Healing in the Corneal Epithelium.** George K. Smelser and Raymond L. Pfeiffer. Arch. Ophth. **39:** 1–8, January 1948.

Grenz rays have been found of value in the treatment of superficial ophthalmic conditions, such as corneal ulcer or episcleritis, and are considered to be safer than ordinary roentgen rays. In view of this use of grenz rays, an investigation was made of their effect on cell division in the intact, and on regeneration of the injured corneal epithelium. It was found that a single exposure (410 r) greatly inhibited cell division in the corneal epithelium of the rat for approximately five days. This period of inhibition was followed by a short interval in which there was a slight rise in the number of mitotic figures, not sufficient, however, to compensate for the five-day deficit in cell division. Once the cells had entered the active stages of mitosis, grenz rays did not affect their division. The rays had no effect on the rate of epithelization of thermal burns made within six days of the irradiation. Thermal burns made eight days after a single irradiation healed more slowly than normal in 12 of the 13 animals studied. This inhibitory effect was conspicuously less by the tenth day after irradiation.

**Absorption of Soft Roentgen Rays By Organic Compounds.** W. Moos. Radiologia clin. **17:** 45–48, January 1948.

The author studied the effect of soft roentgen rays upon microorganisms and examined various organic and inorganic materials as to the absorption of the rays. The most suitable media for these experiments were found to be cellophane and plexiglas (polymetacryl acid).

Measurements with ionization chambers revealed that the half-value-layer of plexiglas is 2.25 times larger than that of cellophane or celluloid. Plexiglas is easier to handle and more useful in laboratory and experimental work. Soft rays of 2.6 Angstroms were used.
EUGENE F. LUTTERBECK, M.D.

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